EXHIBIT 48

APPROVED
DEPARTMENT OF ECOLOGY
ENGINEERING MANAGEMENT SECTION
SIGNATURE Calvin L. Ferguson
DATE 1/24/94

CITY OF SPOKANE

Project No. 13918

COMBINED SEWER OVERFLOW REDUCTION PLAN

January, 1994

Prepared For The

SPOKANE DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION

BY

BOVAY NORTHWEST, INC.
808 East Sprague Avenue
Spokane, Washington
(509) 838-4111

Funded in part by the Washington State Department of Ecology
Centennial Clean Water Fund Grant No. TAX 91-221

EXHIBIT 3
HENDRON
30(B)(6)
6/7/19
Monna Nickeson, CCR 3322

Allen, Katy

From: Arnold, Tom
Sent: Tuesday, January 11, 2000 3:07 PM
To: Hendron, Lars; Raymond, Dick
Cc: Arnold, Dale; Dragisich, Nick; Allen, Katy
Subject: RE: Wastewater Facility Plan (WWFP) Status

Lars, the 1994 CSO Reduction Plan was approved by Ecology in 1994 and finally approved by City Council in December 1999. The WW Facility Plan was approved by City Council in December 1999, ***contingent upon approval by DOE.*** The WWFP was submitted for final review and approval to DOE on November 23, 1999. To date, DOE has not looked at the document. Bottom line, the WWFP has not been approved. As soon as it is approved by DOE, all stamps and signatures will be secured and copies of the 3 volume document will be made available. Thanks, Tom Arnold

-----Original Message-----
From: Hendron, Lars
Sent: Tuesday, January 11, 2000 12:40 PM
To: Arnold, Tom
Subject: RE: Engineering Project File #'s

Thanks for the #s, Tom.

Q: Please confirm: Is the Facility Plan actually approved by Ecology (i.e. "stamped") and adopted by Council?

Lars

-----Original Message-----
From: Arnold, Tom
Sent: Monday, January 10, 2000 5:31 PM
To: Hendron, Lars; Raymond, Dick; Woo, Troy; Genoway, Bill; Correll Jim/SPK (E-mail); Barnes John (E-mail); Shrope Gerry (E-mail)
Cc: Kells, Patty; Peacock, William; Smith, Mike; Hays, Susan; Decker, Sandy; Brown, Ken; Brown, Eldon; Allen, Katy
Subject: Engineering Project File #'s

To whom it may concern: Attached is a spreadsheet with all the file numbers for all the capital projects currently being worked on by Wastewater Management and the associated program management offices (PMO;s). In case you were not aware, CH2M Hill is the TP-PMO and has an office in a temporary trailer located at the treatment plant. Consoer Townsend Envirodyne Engineers, Inc or (CTE) is the CSO-PMO. They have opened a local office on 2nd Avenue near Arthur. Their phone numbers are 625-4668 and 535-5454 respectively. These numbers and additional projects will be added as necessary. Please pass on to other interested parties as needed.

Thanks, Tom Arnold

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
P.O. BOX 47600 • Olympia, Washington 98504-7600 • (206) 459-6000

January 24, 1994

Mr. Brad W. Blegen, P.E.
Spokane City Engineer
Skywalk Level, Municipal Building
Spokane, WA 99201-3343

Re: COMBINED SEWER OVERFLOW REDUCTION PLAN
(Project No. 13918)
Grant No. TAX 91-221

Dear Mr. Blegen:

The city of Spokane's COMBINED SEWER OVERFLOW REDUCTION PLAN, dated January 1994, has been reviewed. This is a comprehensive planning document which addresses flow reduction strategies for the City's combined sewer collection system.

The goals and proposed projects in this Combined Sewer Overflow (CSO) Reduction Plan are consistent with maintaining the water quality of the Spokane-Rathdrum Aquifer and the Spokane River. This plan quantifies and describes the effluent quality of the remaining combined sewer overflows from the City's sewerage system. It also defines and prioritizes a (4) four-phase program for reducing CSOs to the Spokane River and its tributaries within the city of Spokane over a 24-year period (1994 through 2017). This plan is scheduled to be updated at least twice, in 1999 and 2010. As stated in the plan, the estimated reduction in annual overflow volume from all CSO reduction projects described in the plan (Phases 1 through 4) is 70.2 MG per year. The resulting annual CSO volume is estimated to be 8.4 MG per year. Upon completion of Phase 4, it is anticipated that all CSO outfalls will have a discharge frequency of one event per year or less. The estimated cost to complete the reduction projects in this plan is $40 million.

In accordance with RCW 90.48.480 and Chapter 173-245 WAC and on behalf of the Department of Ecology, the subject document is hereby **APPROVED** as a comprehensive, citywide CSO reduction plan. This document does not satisfy the requirements of a project specific engineering report or facility plan from which plans and specifications can be developed. Proper implementation of this plan will require the preparation (and approval by Ecology) of an engineering report (or facility plan), from which plans and specifications can be developed for the construction of proposed project specific CSO reduction facilities. Each such project or facility will be subject to an environmental review (SEPA, NEPA, SERP, etc.) as part of its implementation.

One copy of the approved document is enclosed for your project records. This office is to be notified immediately of any proposed changes or revisions to the approved document. Any such changes or revisions must be issued in the form of addenda, technical appendices, or supplemental reports to the original, approved document and must be approved in writing by the Department of Ecology.

There is no guarantee that any future funding through the Department of Ecology will be available for the planning, design, or construction of future CSO reduction projects.

The Department of Ecology's review and approval of this document is to assure compliance and consistency with the appropriate rules, regulations, guidelines, planning and design criteria, terms of the grant (or loan) agreement, and/or other similar documents. The Department's review shall not be construed as a quality control check or as approval with respect to the completeness, accuracy, or adequacy of this document.

This approval shall not relieve the owner(s) of the proposed facilities from any other approvals as may be required by other governmental reviewing agencies. In addition, this approval does not relieve the owner or the owner's engineer from the responsibilities and liabilities that result from noncompliance with water pollution laws and regulations during the design, construction, or operation of the proposed facilities. Also, this approval does not relieve the owner or the owner's engineer from the responsibilities for the technical adequacy and/or accuracy of the contents of this document.

If you have any questions or need any additional information, please don't hesitate to contact Cal Ferguson, Project Engineer, at (206) 407-6512 or me at (206) 407-6507.

Sincerely,

Michael R. Gardner

Michael R. Gardner, P.E., Supervisor
Facilities Section
Water Quality Financial Assistance Program

MRG:CLF:dp
Enclosure: Approved CSO Reduction Plan, dated January 1994

cc: Alan Gay, Bovay NW, Inc., Spokane
Gerry Shrope, City of Spokane
Larry Neil, City of Spokane
Richard Koch, Ecology/ERO, w/encl.
Karen Beatty, Ecology/WQFA [Grant File]
Cal Ferguson, Ecology/WQFA, w/encl.

RECEIVED
JAN 27 1994
PUBLIC WORKS

[13918RPT.APP]

11/30/99 883

AGENDA SHEET FOR COUNCIL MEETING OF: November 29, 1999

SPOKANE

Wastewater Mgmt.	Tom Arnold	7929
Submitting Department	Contact Person	Phone Ext.

RECEIVED

NOV 17 1999

CITY CLERK'S OFFICE

SPOKANE, WA

CONSENT AGENDA	LEGISLATIVE SESSION	COUNCIL PRIORITY		
✓ Contract	0 Resolution	0 Communications		
⊕ Report	0 Emergency Ordinance	0 Economic Development		
	0 Final Reading Ordinance	0 Growth Management	Clerk's Files:	# OPR 99-924
	0 First Reading Ordinance	0 Human Services		
	0 Special Consideration	0 Neighborhoods	Renews:	#
	0 Hearing	0 Public Safety		
		0 Quality Service Delivery	Cross Reference:	#
		0 Racial Equity & Cultural Diversity		
		⊕ Rebuild & Maintain Infrastructure	ENG/LID:	# 14065

NEIGHBORHOOD/COMMISSION/COMMITTEE NOTIFIED BY SUBMITTING DEPARTMENT: BID: #

Action Taken :

AGENDA WORDING: Recommendation that the City Council accept and authorize the Assistant City Manager of Operations to approve the City's Wastewater Facility Plan (WWFP), contingent upon approval by the Washington State Department of Ecology (Ecology). By association, this includes the acceptance and approval by City Council of the Combined Sewer Overflow (CSO) Reduction Plan which was prepared and approved in 1994 by Ecology.

BACKGROUND: See Attached

FISCAL IMPACT: Expenditure Budget Account #

LIST ATTACHMENTS AS FOLLOWS:
On file for review in Office of City Clerk: Executive Summary of WWFP and CSO Reduction Plan
Full Plans available at Wastewater Maintenance Office, 909 East Sprague Ave.

SIGNATURES OF SUBMITTING OFFICERS:

Director Wastewater Management — Assistant City Manager - Operations — Finance

Legal — City Manager: Dorothy Webster

DISTRIBUTION AFTER COUNCIL ACTION:
Wastewater Maint. (Tom Arnold)
Capital Programs/GIS
Budget Control
Accounting
Neighborhood Services

COUNCIL ACTION:
Accepted and
APPROVED BY
SPOKANE CITY COUNCIL:
November 29 1999
CITY CLERK

3.1

CITY OF SPOKANE

COMBINED SEWER OVERFLOW REDUCTION PLAN

January, 1994

The technical material and data contained in this report were prepared under the supervision and direction of the undersigned whose seal as a professional engineer licensed to practice as such in the State of Washington is affixed below.

Professional Engineer

SPOKANE ENGINEERING DIVISION PROJECT STAFF

Gerald Shrope, Supervisor Engineer
Malcolm Bowie, Project Manager (September, '91 to June, '92)
Lars Hendron, Project Manager (June, '92 to January, '94)

CONSULTANT PROJECT STAFF

Bovay Northwest

Engineering:

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Alan Gay, Project Manager
John Patrouch, Senior Design Engineer
Pamela Pace, Design Engineer
Duane Studer, Design Engineer
Darold Orgill, Engineering Technician
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Camp Dresser & McKee, Inc.
Paul Giguere, Project Engineer
Polly Boissevain, Engineer

ACKNOWLEDGEMENTS

The authors appreciate the assistance given by the following individuals in preparing this report:

Spokane Wastewater Management

Gale Olrich, Director
Tim Pelton
Mike Coster

City of Spokane Environmental Program Director

Dale Arnold

CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

BMP	best management practices
BOD	biological oxygen demand
CSO	combined sewer overflow
CWA	Clean Water Act, also known as the Federal Water Pollution Control Act
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
ENR CCI	Engineering News Record Construction Cost Index
EPA	U.S. Environmental Protection Agency
EWU	Eastern Washington University
FWPCA	Federal Water Pollution Control Act, also known as the Clean Water Act
gpd	gallons per day
gpd/idm	gallons per day per inch diameter mile
HEC	U.S.Army Corps of Engineers Hydraulic Engineering Center
IDF	intensity-duration-frequency (curve)
I/I	infiltration/inflow
MG	million gallon
mgd	million gallons per day
mg/l	milligrams per liter
ml	milliliters
NPDES	National Pollutant Discharge Elimination System
NURP	Nationwide Urban Runoff Program
O&M	operations and maintenance
O&P	overhead and profit
RCW	Revised Code of Washington
SAWTP	Spokane Advanced Wastewater Treatment Plant
SEPA	State Environmental Policy Act
SIRTI	Spokane Intercollegiate Research and Technology Institute
SNAP	Sewer Network Analysis Program
STORM	Storage, Treatment, Overflow Runoff Model
SWMM	Storm Water Management Model
TKN	total kjeldahl nitrogen
TP	total phosphorus
TSS	total suspended solids
μg/l	micrograms per liter
WAC	Washington (State) Administrative Code
WEF	Water Environment Federation
WWTP	wastewater treatment plant

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The purpose of this Plan is to address through compliance action the Revised Code of Washington (RCW) 90.48.480 which requires the control and reduction of combined sewer overflows (CSOs) for the City of Spokane. A combined sewer is designed to convey domestic and commercial sewage during dry weather, and to convey storm water runoff in addition to dry weather flows during wet weather.

Since 1983, when the City of Spokane initiated a 6-year storm sewer separation construction program, CSO volume into the Spokane River and its tributary system has been reduced by an estimated 86 percent (1992 calculations) at a construction cost of $43 million (1992 dollars). Sixty-four percent of the City of Spokane's developed sewer service area was separated by 1990. These separation projects were outlined in the *1977 Facilities Planning Report for Sewer Overflow Abatement* (City of Spokane, 1977). The separations have reduced CSO volume by a total of 491 million gallons (MG) per year.

Through the implementation of this Plan, the City of Spokane will achieve compliance with state and federal water quality criteria that are related to CSOs. This Plan quantifies and describes the effluent quality of the remaining CSOs from the City of Spokane's sewerage system, and defines and prioritizes a four phase program for reducing CSOs to the Spokane River and its tributaries in the City of Spokane. This comprehensive planning document addresses flow reduction strategies for the city's combined sewer collection system. Proper implementation of this Plan will result in basin plans identifying specific projects for CSO reduction in each of the City's CSO collection basins. The preparation of this report is in compliance with federal and state water quality regulations.

The estimated reduction in annual overflow volume from all CSO reduction projects in the Plan, Phases 1 through 4, is 70.2 MG per year. The resulting annual CSO volume will be 8.40 MG per year, and all CSO outfalls will have a discharge frequency of one event per year or less by the completion of Phase 4. The estimated cost to complete the reduction projects in this Plan is $40 million.

There are 30 combined sewer regulators in the City of Spokane's wastewater collection system. A regulator is a structure controlling the flow of wastewater and storm water through the sewer system. Flow in excess of downstream capacity is diverted to a natural water body. There are several outfalls that have more than one contributing regulator structure. Outfalls are numbered from downstream to upstream, consistent with an historical numbering system. As a result of continuing the historical numbering system,

the numbers of outfalls no longer in use have been dropped from the system. Regulating structures are identified with the outfall number and, if there is more than one regulating structure to an outfall, a letter is assigned following the outfall number. Figure ES-1 shows the location of the CSO regulating structures. Table ES-1 describes the location of each CSO outfall.

The contents of this CSO Reduction Plan are governed by Washington State regulation Washington Administrative Code (WAC) Section 173-245-040, "CSO Reduction Plan". The first step in this CSO Reduction Plan is documentation of CSO activity. The next steps are to model CSO activity, analyze control/treatment alternatives, and recommend a schedule of feasible control projects.

The City of Spokane intends to achieve or exceed the goal in WAC 173-245 of reducing combined sewer overflow frequencies to one event per year per CSO outfall. Practically, however, this goal must be achieved over an extended period primarily because of the high cost of modifying the existing combined sewer system. This goal will be consistent with the financial capacity of the City of Spokane as stated in WAC 173-245-040 (2)(e)(ii).

ES.2 WATER QUALITY

The EPA has designated the Spokane-Rathdrum Aquifer as the sole source aquifer for the Spokane River valley. The quality of the groundwater, at present, is suitable for domestic, municipal, commercial, agricultural, and industrial use. The Spokane River was given a "Class A" designation by Ecology (WAC, 1991). This classification requires that the river meet or exceed the conditions required for all beneficial uses. The goals and projects of this CSO Reduction Plan are consistent with maintaining the water quality of the Spokane-Rathdrum Aquifer and the Spokane River.

ES.3 CITY SEWER COLLECTION SYSTEM

The City of Spokane manages over 800 miles of sewer line serving a population of 177,126 (1990 Census). The 30 combined sewer regulating structures discharge through 24 outfall lines during storm events to Latah Creek and the Spokane River. After 1990, an estimated 78 MG of untreated combined sewage was discharged into the Spokane River in the average year. It is estimated that 570 MG was discharged in the average year prior to 1983.

The reduction in CSO volume was primarily due to separation of combined sewered areas by the construction of storm water sewers. The construction effort from 1980 through 1992 is shown in Figure ES-2.

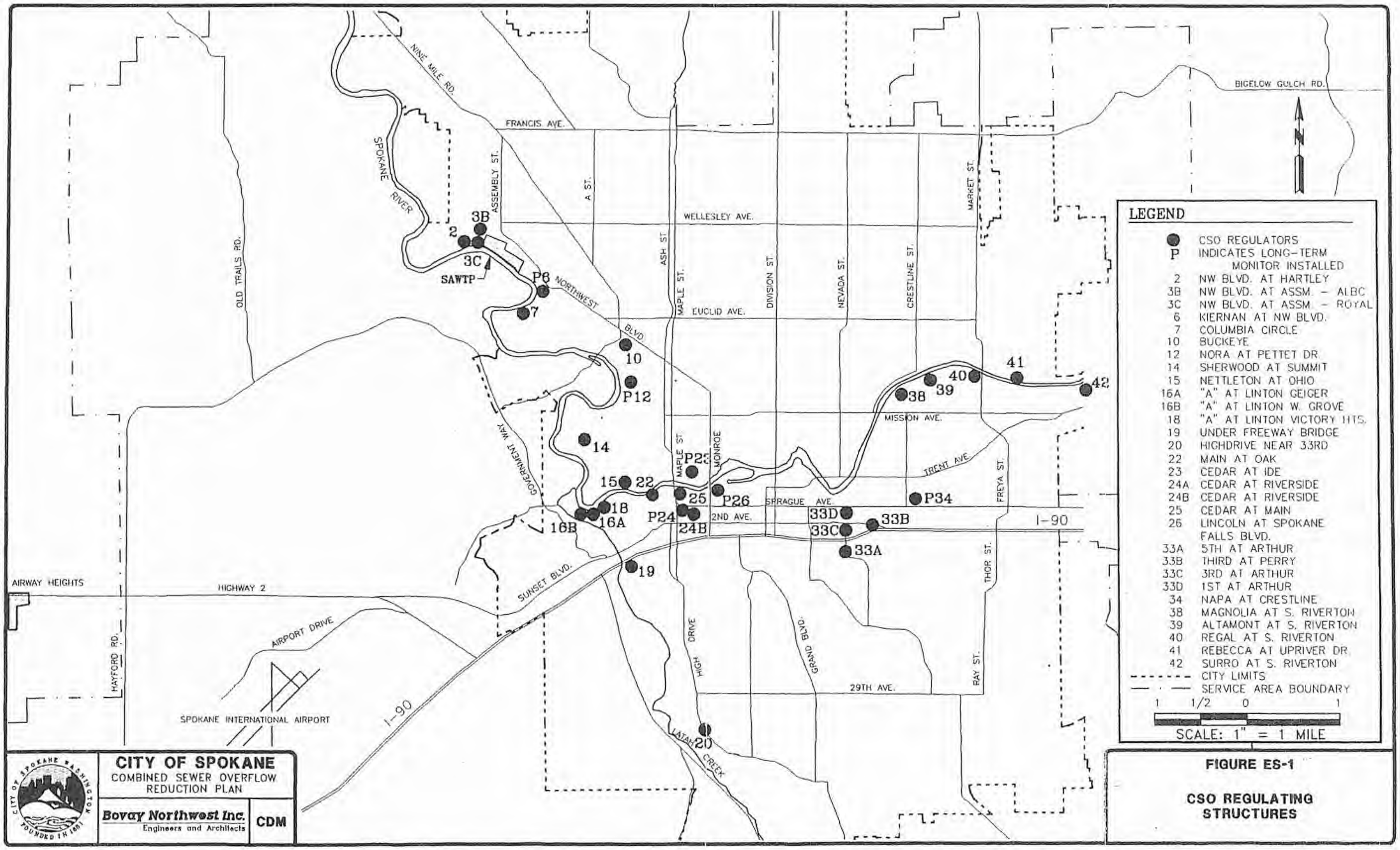

LEGEND
CSO REGULATORS
P INDICATES LONG-TERM MONITOR INSTALLED
2 NW BLVD. AT HARTLEY
3B NW BLVD. AT ASSM. - ALBC
3C NW BLVD. AT ASSM. - ROYAL
6 KIERNAN AT NW BLVD.
7 COLUMBIA CIRCLE
10 BUCKEYE
12 NORA AT PETTET DR.
14 SHERWOOD AT SUMMIT
15 NETTLETON AT OHIO
16A "A" AT LINTON GEIGER
16B "A" AT LINTON W. GROVE
18 "A" AT LINTON VICTORY HTS.
19 UNDER FREEWAY BRIDGE
20 HIGHDRIVE NEAR 33RD
22 MAIN AT OAK
23 CEDAR AT IDE
24A CEDAR AT RIVERSIDE
24B CEDAR AT RIVERSIDE
25 CEDAR AT MAIN
26 LINCOLN AT SPOKANE FALLS BLVD.
33A 5TH AT ARTHUR
33B THIRD AT PERRY
33C 3RD AT ARTHUR
33D 1ST AT ARTHUR
34 NAPA AT CRESTLINE
38 MAGNOLIA AT S. RIVERTON
39 ALTAMONT AT S. RIVERTON
40 REGAL AT S. RIVERTON
41 REBECCA AT UPRIVER DR.
42 SURRO AT S. RIVERTON
CITY LIMITS
SERVICE AREA BOUNDARY
1 1/2 0 1
SCALE: 1" = 1 MILE
CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN
Bovay Northwest Inc.
Engineers and Architects
CDM
FIGURE ES-1
CSO REGULATING STRUCTURES
SPOKANE RIVER
NINE MILE RD.
FRANCIS AVE.
WELLESLEY AVE.
EUCLID AVE.
MISSION AVE.
TRENT AVE.
SPRAGUE AVE.
2ND AVE.
29TH AVE.
BIGELOW GULCH RD.
NORTHWEST BLVD.
GOVERNMENT WAY
SUNSET BLVD.
HIGHWAY 2
AIRWAY HEIGHTS
AIRPORT DRIVE
SPOKANE INTERNATIONAL AIRPORT
I-90
HIGH DRIVE
GRAND BLVD.
LATAH CREEK
OLD TRAILS RD.
HAYFORD RD.
ASSEMBLY ST.
A ST.
ASH ST.
MAPLE ST.
MONROE
DIVISION ST.
NEVADA ST.
CRESTLINE ST.
MARKET ST.
FREYA ST.
THOR ST.
RAY ST.
SAWTP

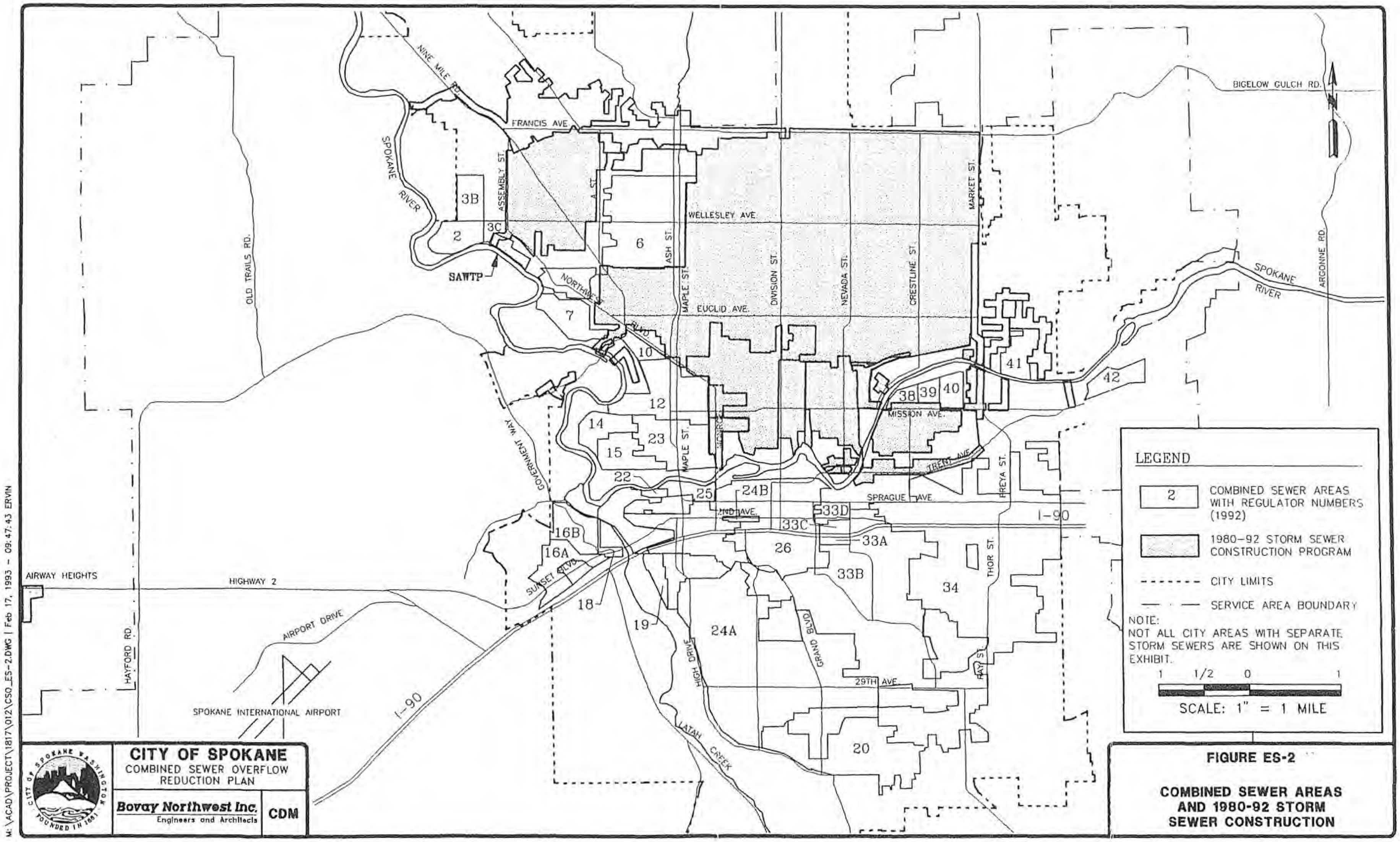
TABLE ES-1. COMBINED SEWER OVERFLOW REGULATOR OUTFALL LOCATIONS

Outfall Number	Outfall Location	Overflow Regulator Locations and Description
Spokane River Discharges (North Bank)		
002	0.5 miles downstream of SAWTP[1]	Hartley at NW Blvd. - LW[2]
003	0.2 miles downstream of SAWTP	B. Assembly at NW Blvd. - Albi - Dam[3] C. Assembly at NW Blvd. - Royal Ct. - LW
006	0.25 miles upstream of SAWTP	Kiernan at NW Blvd. - LW
007	0.4 miles upstream of SAWTP	Columbia Circle at NW Blvd. - LW
010	At Downriver Bridge	Cochran at Buckeye - Side[4]
012	0.55 miles upstream of Bridge	Nora at Pettet Dr. - LW
014	2.0 miles upstream of Bridge	Sherwood at Summit - LW
015	2.5 miles upstream of Bridge	Ohio at Nettleton - LW
016	1.45 miles downstream of Monroe St. Dam	A. "A" at Linton - Geiger - LW B. "A" at Linton - West Grove - LW
018	1.45 miles downstream of Dam	"A" at Linton - Federal - LW
Discharges to Hangman Creek		
019	At High Bridge (East Side)	Seventh at Cannon - Side
020	2.65 miles upstream of High Bridge	S. Manito Relief Sewer - Side
Discharges to Spokane River (South Bank)		
022	0.7 miles downstream of Dam	Main at Oak - Dam
Discharge to Spokane River (North Bank)		
023	0.3 miles downstream of Dam	Cedar at Ide - LW
Discharges to Spokane River (South Bank)		
024	0.3 miles downstream of Dam	Cedar at Riverside - LW Cedar at Riverside - Side
025	0.3 miles downstream of Dam	Cedar at Main - Dam
026	At Monroe Street Dam	Lincoln at Spokane Falls Blvd. - Dam

TABLE ES-1. COMBINED SEWER OVERFLOW REGULATOR OUTFALL LOCATIONS (cont.)

Outfall Number	Outfall Location	Overflow Regulator Locations and Description
033	0.15 miles upstream of J. Keefe Bridge	A. Fifth at Arthur - LW B. Third at Perry - Side C. Third at Arthur - LW D. First at Arthur - LW
034	At Trent Bridge	Crestline at Riverside - Dam
038	0.15 miles upstream of Mission	Magnolia at S. Riverton - LW
039	0.5 miles downstream of Greene	Altamont at S. Riverton - LW
040	0.25 miles downstream of Greene	Regal at S. Riverton - LW
Discharge to Spokane River (North Bank)		
041	0.5 miles upstream of Greene	Rebecca at Upriver Dr. - LW
Discharge to Spokane River (South Bank)		
042	0.5 miles downstream of Upriver Dam	Surro Dr. - Side

1. SAWTP = Spokane Advanced Wastewater Treatment Plant.
2. Leaping weir overflow regulator.
3. Transverse weir or dam overflow regulator.
4. Side-overflow regulator.



ES-6

SPOKANE-PRR-2379401

Each CSO regulating structure drains a CSO basin. The hydrologic characteristics of the 30 CSO basins are shown in Table ES-2.

The combined sewer areas of the City of Spokane are generally on the South Hill and have medium density residential land use, with some exceptions.

ES.4 CSO REDUCTION PROBLEM STATEMENT AND GOALS

Combined sewer overflows impact Spokane River water quality. The data presented in Section 4.2 on annual CSO volume and frequency and in Section 4.3 on select water quality parameters provide the background for characterizing CSOs for the City of Spokane. Spokane's CSOs annual average discharge to the Spokane River and its tributary system is approximately 78 MG. The average CSO concentration of total phosphorus is over 2 milligrams per liter (mg/l). The average fecal coliform count in CSO is approximately 2,000,000 organisms per 100 milliliter (ml), compared to 20,000 organisms per 100 ml in storm drainage. CSO fecal coliforms are at a high enough concentration in CSO to contribute to the fecal coliform counts above ambient levels. The Spokane River had peaks of over 700 organisms/100ml observed in the *1990 Spokane River Study* during storm events.

The goal of the City is to establish an economically viable reduction program utilizing the data gathered for and presented in this Plan. WAC 173-245-040, Section (2)(e) states "Factors which municipalities and the department shall use to determine compliance schedules shall include but not be limited to:

- (i) Total cost of compliance
- (ii) Economic capability of the municipality
- (iii) Other recent and concurrent expenditures for improving water quality; and
- (iv) The severity of existing and potential environmental and beneficial use impacts."

This section means reducing overflow to a one event per year frequency over time as the City is financially able will meet with Ecology approval. Therefore the City will work toward the goal of one overflow per year per CSO outfall. The City is using the assumption that this criteria can be met by restricting overflow at each regulator upstream of the outfall to one event per year.

TABLE ES-2. CSO BASIN DESCRIPTION AND CHARACTERISTICS

CSO No.	CSO Regulator Location	Basin Area (ac)[2]	Average Sanitary Flow (Measured)[1] (mgd)[3]	Maximum Intercepted Flow (Measured) (mgd)
2	NW Blvd. at Hartley - LW[4]	84	0.054	0.30
3B	NW Blvd. at Assembly (from Albi)- Dam[5]	10	0.039	0.22
3C	NW Blvd. at Assembly (from Royal) - LW	17	0.065	0.47
6	Kiernan at NW Blvd. - LW	619	0.642	2.94
7	Columbia Circle - LW	190	0.141	2.07
10	Cochran at Buckeye - Side[6]	75	0.088	1.06
12	Nora at Pettet - LW	345	0.695	3.80
14	Sherwood at Summit - LW	79	0.096	0.80
15	Nettleton at Ohio - LW	129	0.333	1.97
16A	"A" Street at Linton - LW	56	0.243	2.90
16B	"A" Street at Linton - LW	75	0.258	1.27
18	1st at "A" Street - LW	11	0.079	0.25
19	Under Freeway Bridge - Side	41	0.046	35.40
20	High Drive near 33rd - Side	407	0.189	6.52
22	Main at Oak St. - Dam	38	0.160	2.20
23	Cedar at Ide - LW	168	0.254	2.00
24A	Cedar at Riverside - LW	1,385	3.304	12.20
24B	Cedar at Riverside - Dam[7]	20	N/A	N/A
25	Cedar at Main - Dam	24	0.115	0.59
26	Lincoln at Spokane Falls - Dam	980	12.000	36.80
33A	5th at Arthur - LW	53	0.049	2.00
33B	3rd at Perry - Side	1,256	1.600	19.32
33C	3rd at Arthur - LW	14	0.050	0.45
33D	1st at Arthur - LW	45	0.250	0.76
34	Riverside at Napa/Crestline - Dam	1,409	3.500	13.77
38	Magnolia at S. Riverton - LW	73	0.087	0.69
39	Altamont at S. Riverton - LW	51	0.029	0.28
40	Regal at S. Riverton - LW	56	0.071	0.60
41	Rebecca at Upriver Dr. - LW	87	0.081	1.57
42	Surro at S. Riverton - Side	82	0.330	2.00

1. Measured in 1989, 1990 and/or 1992, except 3B, 3C, 19, 22, 24B, 33A, 33D.
2. ac = acres
3. mgd = million gallons per day
4. Leaping weir or dam overflow regulator
5. Transverse weir or dam overflow regulator
6. Side-overflow regulator
7. Not monitored or modeled at time of plan

ES.4.1 CSO QUANTITY

Annual combined sewer overflow volumes for each CSO regulator were determined with a calibrated hydrologic model. These volumes are presented in Table ES-3. CSO volume and frequency determinations were made with simulations considering snowmelt and not considering snowmelt, as indicated in Table ES-3. The frequencies and volumes used to analyze alternatives are from the snowmelt simulations because they result in higher volumes.

ES.4.2 POLLUTANT LOADS

Water quality data from CSOs and the Spokane River was collected for the *1990 Spokane River Study*. Analysis of the data indicated there is not a statistically significant correlation between land use and contaminant load in CSO effluent. The pollutant load was therefore assumed to be uniform and an average load was assigned to each CSO based on annual volumes and 1-year storm event volumes estimated with a computer model. Data on CSO water quality from this effort is shown in Table ES-4, and dry weather and wet weather Spokane River water quality data is shown in Table ES-5.

TABLE ES-3. AVERAGE ANNUAL CSO VOLUMES AND FREQUENCIES

CSO No.	CSO Location	Annual Overflow Volume[1,2] (MG)[4] With Snow Melt	Annual Overflow Volume[1,2] (MG)[4] Without Snow Melt	Frequency of Overflows[3] (annual) With Snow Melt	Frequency of Overflows[3] (annual) Without Snow Melt
2	NW Blvd. at Hartley	1.72	1.48	40	40
3B	NW Blvd. at Assembly (from Albi)	0.00	0.00	1	2[5]
3C	NW Blvd. at Assembly (from Royal)	1.94	1.67	51	55[5]
6	Kiernan at NW Blvd.	14.12	10.08	34	33
7	Columbia Circle	0.81	0.72	13	12
10	Cochran at Buckeye	0.27	0.22	7	6
12	Nora at Pettet	9.65	7.40	35	33
14	Sherwood at Summit	0.86	0.71	17	15
15	Nettleton at Ohio	4.47	3.92	34	34
16A	"A" Street at Linton	0.01	0.00	0	0
16B	"A" Street at Linton	0.50	0.47	12	11
18	1st at "A" Street	0.00	0.00	1	1
19	Under Freeway Bridge	0.00	0.00	0	0
20	High Drive near 33rd	0.55	0.44	3	3
22	Main at Oak St.	0.00	0.00	0	0
23	Cedar at Ide	1.69	1.51	18	17
24A	Cedar at Riverside	2.12	1.92	3	3
24B	Cedar at Riverside	N/A	N/A	N/A	N/A
25	Cedar at Main	0.35	0.33	19	18
26	Lincoln at Spokane Falls	19.73	16.44	15	14
33A	5th at Arthur	0.00	0.00	0	0
33B	3rd at Perry	2.30	2.05	5	5
33C	3rd at Arthur	0.12	0.11	11	10
33D	1st at Arthur	2.03	1.78	42	42
34	Riverside at Napa/Crestline	11.78	9.95	13	13
38	Magnolia at S. Riverton	0.28	0.22	10	9
39	Altamont at S. Riverton	1.06	0.89	34	34
40	Regal at S. Riverton	1.45	1.25	32	31

TABLE ES-3. AVERAGE ANNUAL CSO VOLUMES & FREQUENCIES (cont.)

CSO No.	CSO Location	Annual Overflow Volume[1, 2] (MG)[4] With Snow Melt	Annual Overflow Volume[1, 2] (MG)[4] Without Snow Melt	Frequency of Overflows[3] (annual) With Snow Melt	Frequency of Overflows[3] (annual) Without Snow Melt
41	Rebecca at Upriver Dr.	0.52	0.47	11	10
42	Surro at S. Riverton	0.31	0.29	7	6
TOTAL		78.64	64.31		

1. STORM simulation includes effects of snowmelt.
2. Values rounded to nearest 10,000 gallons.
3. A "0" indicates less than one event in 2 years.
4. MG = million gallons.
5. High overflow frequencies without snowmelt are due to combining runoff events during period of low temperature.

TABLE ES-4. CSO WATER QUALITY

AVERAGE INPUT TO SPOKANE RIVER FROM CSO DURING STORMS OF 0.15 INCHES OR GREATER							
Parameter Concentrations					Average Load to River		
Location	TKN[1] (mg/l)[4]	TP[2] (mg/l)	TSS[3] (mg/l)	Flow (cfs)[5]	TKN (lbs)[6]	TP (lbs)	TSS (lbs)
Measured							
CSO 12	10.0	2.3	251	1.545	20.10	4.65	505.28
CSO 15	2.8	3.5	266	0.084	2.61	3.30	247.95
CSO 26	8.5	1.2	211	3.218	35.13	9.21	866.43
CSO 34	9.9	3.6	435	0.945	24.37	8.85	1069.67
Estimated - Calculated Flow Weighted Average							
CSO 2	7.8	2.9	291	0.046	2.79	1.05	104.00
CSO 3B	7.8	2.9	291	0.004	0.01	0.003	0.30
CSO 3C	7.8	2.9	291	0.041	3.15	1.18	117.39
CSO 6	7.8	2.9	291	0.447	23.00	8.60	856.02
CSO 7	7.8	2.9	291	0.069	1.32	0.50	49.27
CSO 10	7.8	2.9	291	0.040	0.45	0.17	16.67
CSO 14	7.8	2.9	291	0.056	1.71	0.16	23.03
CSO 16A	7.8	2.9	291	0.022	0.02	0.001	0.20
CSO 16B	7.8	2.9	291	0.134	3.33	0.32	44.74
CSO 18	7.8	2.9	291	0.003	0.01	0.001	0.08
CSO 19	7.8	2.9	291	*	Overflows less than 1/year		
CSO 20	7.8	2.9	291	0.060	0.22	0.02	2.97
CSO 22	7.8	2.9	291	0.022	0.01	<0.001	0.07
CSO 23	7.8	2.9	291	0.100	3.37	0.32	45.31
CSO 24	7.8	2.9	291	0.736	4.22	0.40	56.83
CSO 25	7.8	2.9	291	0.020	0.70	0.07	9.45

TABLE ES-4. CSO WATER QUALITY (cont.)

AVERAGE INPUT TO SPOKANE RIVER FROM CSO DURING STORMS OF 0.15 INCHES OR GREATER							
	Parameter Concentrations				Average Load to River		
Location	TKN[1] (mg/l)[4]	TP[2] (mg/l)	TSS[3] (mg/l)	Flow (cfs)[5]	TKN (lbs)[6]	TP (lbs)	TSS (lbs)
CSO 33A	7.8	2.9	291	*	Overflows less than 1/year		
CSO 33B	7.8	2.9	291	0.484	4.59	0.44	61.80
CSO 33C	7.8	2.9	291	0.012	0.24	0.02	3.19
CSO 33D	7.8	2.9	291	0.052	4.04	0.38	54.37
CSO 38	7.8	2.9	291	0.029	0.55	0.05	7.45
CSO 39	7.8	2.9	291	0.034	2.12	0.20	28.53
CSO 40	7.8	2.9	291	0.049	2.89	0.27	38.88
CSO 41	7.8	2.9	291	0.050	1.04	0.10	13.95
CSO 42	7.8	2.9	291	0.048	0.61	0.06	8.22
TOTALS					137	46.6	4734

1. TKN = total kjeldahl nitrogen.
2. TP = total phosphorus.
3. TSS = total suspended solids.
4. mg/l = milligrams per liter.
5. cfs = cubic feet per second.
5. lbs = pounds.

TABLE ES-5. SPOKANE RIVER WATER QUALITY

	Average Wet Weather River Values Parameter Concentrations				Average Ambient (Dry Weather) River Values Parameter Concentrations		
LOCATION	TKN[1] (mg/l)[2]	TP[3] (ug/l)[4]	TSS[5] (mg/l)	FLOW (cfs)[6]	TKN (mg/l)	TP (ug/l)	TSS (mg/l)
Waterworks	0.29	17	1.5	5978	0.17	13	1.5
CSOs 41, 42							
Greene Street Bridge	0.31	15	2	5978	0.19	12	1.5
CSOs 38, 39, 40							
Mission Street Bridge	0.33	17	1.5	5978	0.19	16	1.5
Trent Avenue Bridge	0.29	15	1.5	5978	0.21	14	1.5
CSOs 33, 34							
Division Street Bridge	0.31	21	1.5	5979.6	0.17	18	1.5
CSOs 23, 24, 25, 26							
Maple Street Bridge	0.38	20	2	5982	0.16	16	1.5
CSOs 16, 18, 22							
Above CSO 15 Outfall	0.52	24	2	5982	--	--	--
CSOs 19, 20							
Latah Creek Mouth	1.23	148	25	45.75	0.84	173	245
CSO 14, 15							
Above CSO 12 Outfall	0.47	22	3	6027.75	--	--	--
CSO 12							
Fort Wright Bridge	0.81	24	2	6029.75	0.34	47	48
CSOs 7, 10							
Old Children's Home	0.9	19	3	6040	--	--	--
SAWTP CSOs 2, 3, 6							
Bowl & Pitcher	1.02	67	2	6100	0.3	54	39
Seven Mile Bridge	0.7	63	2	6100	0.28	61	29

1. TKN = total kjeldahl nitrogen.
2. mg/l = milligrams per liter.
3. TP = total phosphorus.
4. ug/l = micrograms per liter.
5. TSS = total suspended solids.
6. cfs = cubic feet per second.

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ES.5 CONTROL/TREATMENT TECHNOLOGIES

Currently available CSO control/treatment technologies for application in Spokane as well as all technologies required by WAC 173-245-040 were reviewed. The technical and financial practicality of control/treatment technologies were examined, and include the following:

- Best management practices, such as street cleaning, interceptor system flushing, catch basin cleaning, sewer rehabilitation to reduce infiltration and inflow (I/I), pretreatment programs, on-site retention using grass swales, and City wastewater ordinances.
- Store and treat, including on-site detention storage, using flow control devices, in-line storage, off-line storage, storage in existing lines, and control with interceptor optimization.
- Increased interceptor and additional primary treatment capacity at the Spokane Advanced Wastewater Treatment Plant (SAWTP).
- Remote site primary treatment.
- Separation, including full and partial separation.

While a single reduction method may be appropriate for any particular CSO (i.e., storage only or primary treatment only), alternatives evaluated in this Plan also include strategies using a combination of the controls listed in WAC 173-245-040.

As part of an integrated approach to CSO reduction, more than one alternative is usually incorporated in order to achieve the one event per year goal. The technologies selected as practical for application in reducing Spokane's CSO discharges are shown in Table ES-6.

TABLE ES-6. SUMMARY OF CSO CONTROL/TREATMENT TECHNOLOGIES

Technologies	Feasibility/Pollutant Removal Efficiency
Street Surface Cleaning	High Frequency May Provide Efficient Removal
Catch Basin Cleaning	High Frequency May Provide Efficient Removal
Combined Sewer Flushing	Limited Effect on CSO Quality
Infiltration/Inflow Control	May reduce base flows
Water Use Reduction	May reduce base flows
On-Site Retention	Can Reduce Storm Flow
Wastewater Ordinances	On-Site Control Can Reduce Storm Flow
On-Site Detention	Can Reduce Storm Peaks
In-Line Storage and Control	Prevents Peak Flow from Reaching STP*
Off-Line Storage and Control	Prevents Peak Flow from Reaching STP
Storage in Existing Lines	Effective with Available Capacity
Increase Interceptor and STP	Major Reconstruction of City Lines Possible
Existing Capacity Optimized	Lower Interceptor and STP Costs
Remote Primary Treatment	No Regulations on CSO Treatment
Full Separation	High Cost, May Need Treatment in Future
Partial Separation	Lower Cost, May Need Treatment in Future

* Sewage treatment plant

ES.6 CRITERIA FOR EVALUATION AND ANALYSIS OF CONTROL AND TREATMENT ALTERNATIVES

The following analysis and evaluation factors were used to screen the control/treatment alternatives listed in Section ES.5:

- Water quality and sediment impact
- Effect on the advanced wastewater treatment facility
- Construction and operation and maintenance (O&M) costs
- Economic capability of municipality
- Surcharge of interceptor and interceptor capacity
- Operational impacts due to added complexity
- Future regulations
- Practicality and benefits of phased and integrated implementation
- Compliance with the State Environmental Policy Act (SEPA).

The most important analyzing and evaluating factor was water quality and sediment impact. All control and/or treatment alternatives were screened on the basis of water quality for selection as a control/treatment project. In addition, cost factors such as effect on the wastewater treatment facility, construction and O&M costs, the economic capability of the City, interceptor capacity increases, and operational impacts due to added complexity were all converted to present value costs for ease of comparison. Additional factors used to screen project options were future regulations and the practicality and benefits of phased and integrated implementation. Integrated implementation means that individual basins may utilize more than one control/treatment alternative to reduce CSO, and that CSO reduction will be approached on both an individual basin and system-wide basis. Compliance with the SEPA is consistent with the primary goal of water quality protection but may result in increased costs.

ES.7 SUMMARY OF ALTERNATIVES ANALYSIS

The matrix shown in Table ES-7 summarizes the results of the alternatives analysis. The basis of cost comparison between the alternatives is the cost per gallon of reduction in CSO volume. Those alternatives with the lowest cost per gallon that are compatible with reducing overflow frequency to one event per year and meet the other criteria listed in Section ES.6 are preliminary strategy selections. These strategies are discussed in Section ES.8.

The City of Spokane has several strategies available to it for City-wide flow and CSO reduction. These strategies can be enacted by City ordinances or implemented as operational policy by the appropriate City agency. The impact of these strategies on individual CSO basins will be addressed in CSO basin plans. None of the recommended projects in this Plan will be implemented prior to completion of the appropriate Basin Plans.

ES.8 CONTROL TREATMENT PROJECTS SCHEDULE

This section presents the priority ranked project schedule to address reduction of combined sewer overflow in Spokane. Five general control/treatment project options are presented first. A control/treatment project approach was selected from these options. Each basin project in the selected approach schedule is described. These projects have been screened using the criteria outlined in Section ES.6. The project schedule provides for "the greatest reasonable reduction of combined sewer overflows at the earliest possible date" (WAC 173-245-020) taking into account the factors outlined in Section ES.6.

ES.8.1 PRIORITY RANKING

WAC 173-245-040, CSO Reduction Plan, requires that each municipality propose a ranking of its selected treatment/control projects using the following criteria.

1. Highest priority shall be given to reduction of CSOs which discharge near water supply intakes, public primary contact recreation areas, and potentially harvestable shellfish areas.

2. Documented, probable, and potential environmental impacts of the existing CSO discharges.

3. A cost-effectiveness analysis of the proposed projects. This can include a determination of the monetary cost per annual mass pollutant reduction, per annual volume reduction, and/or per annual frequency reduction achieved by each project.

TABLE ES-7. PRELIMINARY PROJECT SELECTIONS FOR EACH CSO

CSO	On-Site Retention	On-Site Detention	Interceptor Optimization	CSO 6 Storage	CSO 12 Storage	East Trent Central Storage	Riverfront w/o 24A Storage	Maple & Pacific Storage	Separation
2			X						
3C	X								X
6	X			X					
7	X		X						
10			X						
12	X				X				
14					X				
15	X				X				
16B			X						
20									X
23		X	X						
24A								X	
25	X								X
26							X		
33B	X					X			
33C						X			
33D						X			
34						X			
38						X			
39	X					X			
40	X					X			
41	X					X			
42	X					X			

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Spokane does not have any surface water supply intakes from the Spokane River, public primary contact areas, or harvestable shellfish areas near any of its outfalls. Therefore this criterion does not affect the ranking of projects. Downstream of all the outfalls there are a number of public beaches at Long Lake which are affected by all CSOs.

A given project's volume and frequency reduction at the affected CSO were used as the primary ranking of the project, as outlined in Section ES.6. The second screening tool for ranking projects was cost effectiveness. Finally, projects were screened for the other criteria outlined in Section ES.6, including impact to the interceptor and treatment plant capacities, operations complexity, and future regulations.

ES.8.2 CSO REDUCTION PROJECT OPTIONS

Five project options for addressing CSO reduction were evaluated using the criteria outlined in Section ES.6. These project options are shown in Table ES-8. The most cost effective approach that meets the criteria of Section ES.6 is storage with existing capacity optimization in conjunction with Best Management Practices (BMP). Section ES.8.3 addresses the specific components of this project option.

ES.8.3 CSO REDUCTION PROJECT SCHEDULE

The four phase project schedule and costs for reducing the City of Spokane's combined sewer overflows are shown in Table ES-9. The locations and affected basins of the first phase projects are shown in Figure ES-3. The implementation of this Plan was divided into four phases to provide a cost effective means for CSO reduction. Further planning on the basis of individual CSO Basins in the first three phases will result in construction cost reductions and sufficient time to evaluate additional, basin-specific data such as pipe condition, land use, and the impact of implementing low-cost best management practice technologies.

The first phase of the program will be to write and then begin implementing basin plans for the 15 largest CSO basins. The basin plans will consider the ordinances and BMP projects recommended in this CSO Reduction Plan as well as additional projects that may be applicable. Basin plans will be engineering reports from which plans and specifications can be developed for specific CSO reduction projects.

The second phase of CSO reduction in Spokane will be to analyze the effectiveness of the first 15 basin plan BMP projects and update this plan with the results of the new information. Following the CSO reduction plan update, the remaining projects outlined in this report, or as revised, will be implemented during the final two phases of CSO reduction to achieve the one event per year (on average) goal for each CSO outfall.

TABLE ES-8. CSO REDUCTION PROJECT OPTIONS[1]

	1. No Additional Reduction Beyond Best Management Practice	2. Storage With Exist. Capacity Optimization	3. Remote-Site Treatment	4. Separate Remaining Basins	5. Expand Interceptor and SAWTP[2] Capacity
Cost[3]:	$0	$33,189,000 ($.64 per gallon)	$34,197,000 ($.66 per gallon)	$74,359,000 ($1.24 per gallon)	$50,000,000 ($.83 per gallon)
Advantages:	No additional cost.	Lowest cost to meet Ecology's one event per year criteria.	Relatively low cost.	Elimination of CSO to SAWTP.	Elimination of untreated CSO discharge.
	Low maintenance.	Does not impact existing peak flow capacity at SAWTP with proper control for 5-year storms.	Elimination of most CSO to SAWTP. Reduces overflow to 8.4 MG per year.	Total separation of all CSO basins.	Lower cost than separation.
	No added impact on treatment plant.	Reduces overflow to 8.4 MG per year, on average.	Sized to handle 2010 increases projected with draft facility plan.	Will not require any interceptor capacity increases.	Will not require remote facilities.
	No additional discharge points.	Sized to handle 2010 increases projected with draft facility plan.	Will not require major interceptor capacity increases.		No additional untreated storm water discharge.
Disadvantages:	Will not meet the State's one event per year criteria.	Will require capacity increase for interceptor (not in above cost) immediately above SAWTP to avoid surcharging the interceptor.	State standards for treatment of CSO are unclear and will probably become more stringent.	State standards for treatment of storm water will probably be implemented in the future.	High cost solution.
	Will leave almost 60 MG of CSO per year.	Will decrease the average daily capacity of the plant for new, rate-paid sanitary wastewater sources.	New outfalls would need to be in city NPDES permit.	High cost solution.	The necessary amount of land is probably not available at the SAWTP site.
	Still allows a peak flow of 140 mgd to SAWTP which may necessitate replacing joints in interceptor immediately above SAWTP.	Still allows a peak flow of 130 mgd to SAWTP during storm events.	New outfalls would be subject to mixing zone requirements for treatment plants.	Total suspended solids discharge to river may actually increase.	May make capacity modifications to handle additional sanitary flow more difficult.
		Requires treatment of nearly all storm water at SAWTP.	Higher cost than storage with capacity optimization.		
		New NPDES[4] outfall from East Trent storage site.	Still requires treatment of highly concentrated waste from remote-site treatment facilities.		

1. All options include utilizing Best Management Practice (BMP) to the fullest practical extent, including retention swales, sewer use ordinances and maintenance. The cost of this step is estimated to be $6,560,000 to reduce CSO by 18 MG per year ($.36 per gallon).
2. SAWTP= Spokane Advanced Wastewater Treatment Plant.
3. All costs are in 1992 dollars.
4. NPDES= National Pollutant Discharge Elimination System.

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TABLE ES-9. CSO REDUCTION SCHEDULE

Year	CSO Basin Regulator	Projects	Capital Cost ($1,000)	Annual Maint. & Operation ($1,000)
Phase 1				
1994	26	Basin Plan	100	0
1995	26	I/I[1] Reduction	100	0
	6	Basin Plan	50	0
	34	Basin Plan	50	0
	12	Basin Plan	50	0
	15	Basin Plan/Monitor	50	0
1996	26	Weir Modification, I/I	160	0.1
	6	Retention,I/I Reduction, Weir Modif.	303	2.1
	34	I/I Reduction, Weir Change	110	0.1
	12	Retention, I/I Reduction, Weir	152	0.5
	33B	Basin Plan	25	0
	24	Basin Plan	25	0
	33D	Basin Plan	25	0
	3C&2	Basin Plan	25	0
1997	15	Retention, I/I Reduction, Weir Modif.	371	2.8
	33B	Retention, I/I Reduction, Weir Modif.	272	1.6
	24	I/I Reduction, Weir Modification	110	0.1
	33D	I/I Reduction, Weir Modification	85	0.2
	3C&2	I/I Reduction, Weir Modif., Monitor	155	0.3
	23	Basin Plan	25	0
	38,39,40	Basin Plan	25	0
	14	Basin Plan	25	0
	7	Basin Plan	25	0
	41	Basin Plan	25	0
	16B	Basin Plan	25	0
1998	23	Detention Storage, I/I, Weir Modif.	1,470	1.1
	38	I/I Reduction, Weir Modification	70	0.1
	39	Retention, I/I Reduction, Weir Modif.	121	0.9
	40	Retention, I/I Reduction, Weir Modif.	157	1.0
	14	I/I Reduction, Weir Modification	70	0.1
	7	Retention, I/I Reduction, Weir Modif.	651	1.9
	41	Retention, I/I Reduction, Weir Modif.	124	0.6
	16B	I/I Reduction, Weir Modification	70	0.1
		Phase 1 - Subtotal	5,101	13.6
Phase 2				
1999 to 2000		CSO Reduction Plan Update, includes Review and Analysis, Revision of Projects	250	0
		Phase 2 - Subtotal	250	0
Phase 3				
2001	25	Basin Plan	25	0
	42	Basin Plan	25	0
	10	Basin Plan	25	0
	33C	Basin Plan	25	0
	20	Basin Plan	25	0

TABLE ES-9 CSO REDUCTION SCHEDULE (cont.)

Year	CSO Basin Regulator	Projects	Capital Cost ($1,000)	Annual Maint. & Operation ($1,000)
2002	3C 25 42 38 10 33C 20	Retention, Separation Retention, Separation I/I, Weir Change I/I, Weir Change I/I, Weir Change I/I, Weir Change Separation, I/I	273 377 118 70 70 70 80	2.7 2.6 0.5 0.1 0.1 0.1 0.1
2003 to 2005		Interceptor Upgrades	5,476	0
2006 to 2008		SAWTP[2] Upgrades	2,500	4
2009	2 23 7 16B 10	Optimization Optimization Optimization Optimization Optimization	1 1 1 1 1	0 0 0 0 0
		Phase 3 - Subtotal	9,164	9.2
Phase 4				
2010 to 2012		CSO Reduction Plan Update, including Review and Analysis, Revision of Projects	250	0
After 2012	6	1.7 MG[3] Off-Line Storage Treatment Cost	1,499 425	6.8
	12,14,15 West Central	1.5 MG Off-Line Storage Treatment Cost	1,217 375	6.0
	24 Maple & Pacific	0.9 MG Off-Line Storage Treatment Cost	573 225	3.4
	26 Riverfront Park	5 MG Off-Line Storage Treatment Cost	3,423 1,250	20
	33A, 33B, 33C, 33D, 34,38,39, 40,41,42 East Trent Site	8.5 MG Off-Line Storage Treatment Cost	6,836 2,125	34
2017		44 mgd[4] Primary Clarifier Capacity	7,000	32
		Phase 4 Subtotals	25,198	102.2
CSO REDUCTION TOTALS			39,713	125.0

1. I/I= infiltration/inflow
2. SAWTP- Spokane Advanced Wastewater Treatment Plant
3. MG= million gallons
4. mgd= million gallons per day

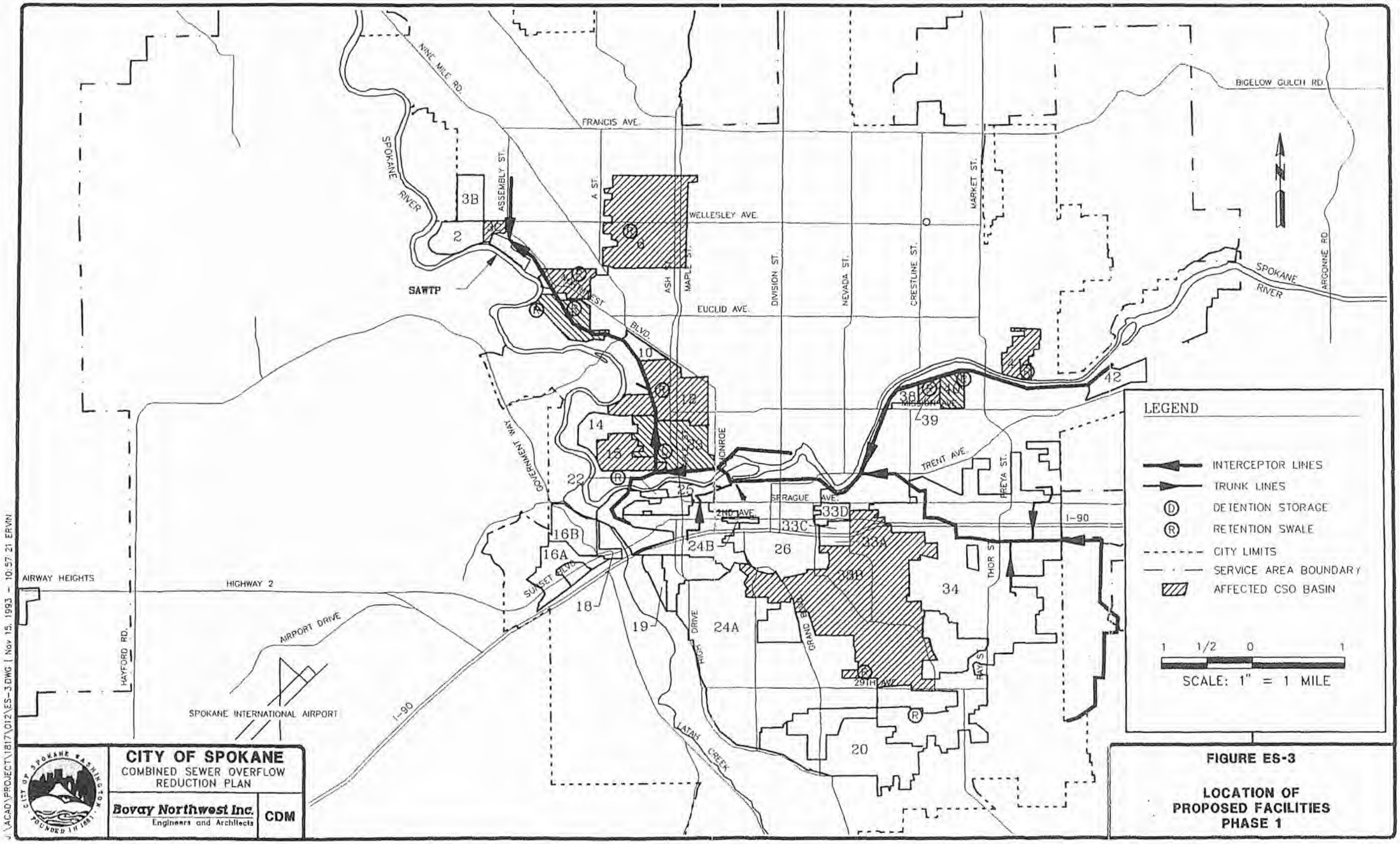


FIGURE ES-3

LOCATION OF PROPOSED FACILITIES PHASE 1

The third phase covers the remainder of the period to 2010, including writing basin plans for the CSOs currently discharging more than once per year that were not covered in the first phase. Phase 3 basin plans are separate from those in Phase 1 to allow for re-evaluation and better design of Phase 3 projects, if necessary, following analysis of the first set of projects in Phase 2. Phase 3 also includes improvements to the existing interceptor system and the wastewater treatment plant.

The fourth and final phase of implementation will occur after 2012, and be preceded by a final update of this plan based on data from projects implemented during the first three phases. The fourth phase will include capital intensive projects to construct remote storage. These projects are presented for the purpose of project identification in this plan. The locations and affected basins of projects in the third and fourth phases are shown in Figure ES-4.

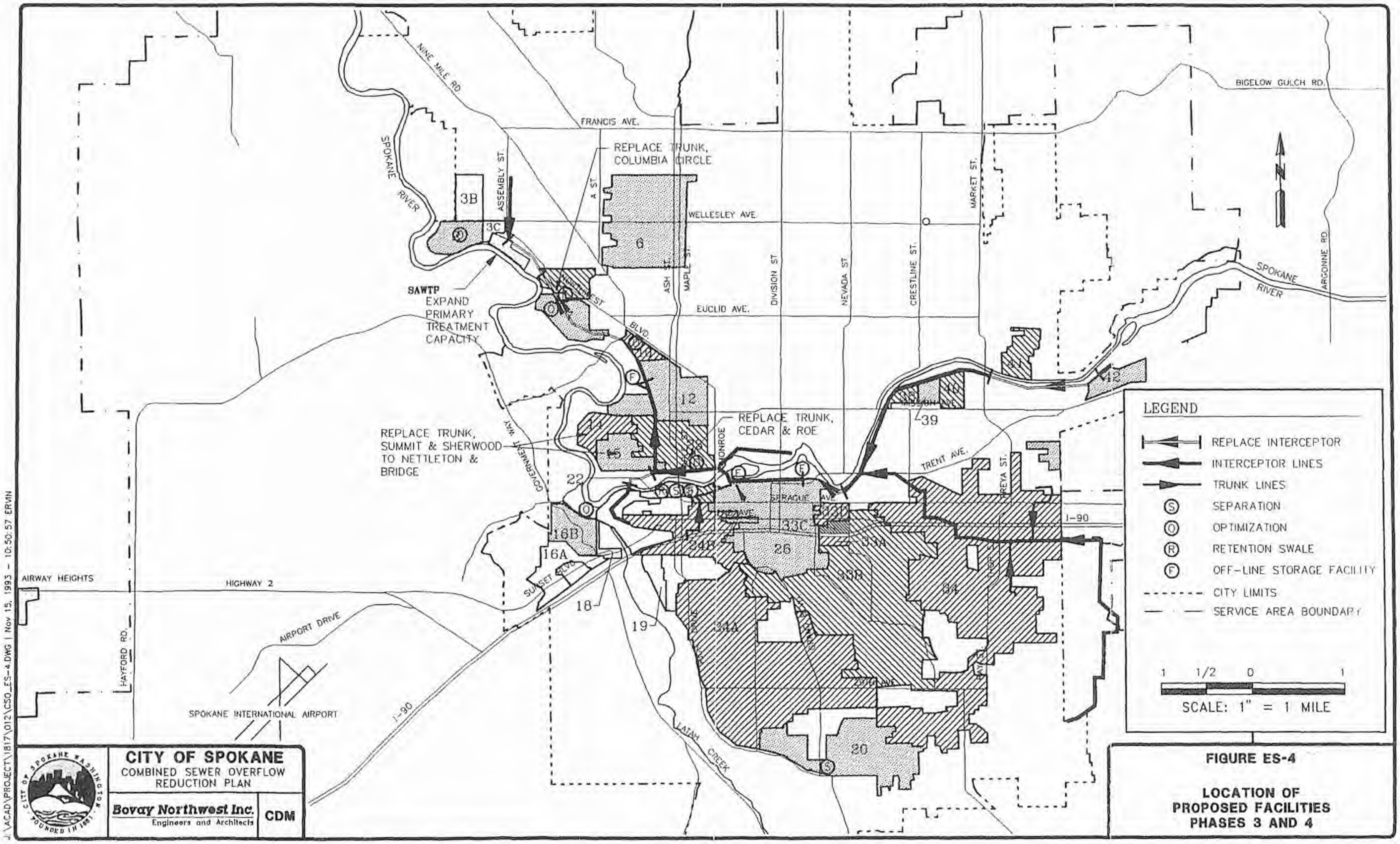
Details on capital improvement alternatives are in Chapter 7 of the Plan.

ES.8.3.1 Phase 1

The initial basin plans are for those basins found to discharge the greatest amount of CSO as shown in Table ES-3. The BMP and weir modification projects listed in Table ES-9 are those found to be most cost effective in the analysis presented in Section ES.7. The additional analysis in the individual basin plans may indicate better alternatives which will be implemented instead of those listed in Table ES-9. These projects will be re-evaluated for effectiveness through analysis of long-term flow monitor data collected at new regulating structures downstream of the projects. The existing long-term flow monitoring and rainfall data gathering efforts will be continued. Basin plans will be engineering reports from which plans and specifications can be developed for specific CSO reduction projects.

In addition to preparation of the applicable basin plans, the suggested first phase projects include:

- Revising and enforcing existing city regulations to make CSO control more effective. This may include providing a financial incentive in the form of municipal utility rate reductions for businesses that store runoff on-site. Storage methods will include on-site retention swales in parking lots and on-site detention tanks. The City may conduct an investigation in cooperation with building owners in the central business district to determine the extent of inflow from basement sumps. A consensus solution will be developed, agreed upon by downtown building owners, to address inflow from basement sumps to the combined sewer system. Part of such a solution may be a revised wastewater rate structure.


CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN
Bovay Northwest Inc. Engineers and Architects
CDM
FIGURE ES-4
LOCATION OF PROPOSED FACILITIES PHASES 3 AND 4
LEGEND
REPLACE INTERCEPTOR
INTERCEPTOR LINES
TRUNK LINES
SEPARATION
OPTIMIZATION
RETENTION SWALE
OFF-LINE STORAGE FACILITY
CITY LIMITS
SERVICE AREA BOUNDARY
SCALE: 1" = 1 MILE
REPLACE TRUNK, COLUMBIA CIRCLE
SAWTP EXPAND PRIMARY TREATMENT CAPACITY
REPLACE TRUNK, CEDAR & ROE
REPLACE TRUNK, SUMMIT & SHERWOOD TO NETTLETON & BRIDGE
FRANCIS AVE.
WELLESLEY AVE.
EUCLID AVE.
TRENT AVE.
BIGELOW GULCH RD.
HIGHWAY 2
AIRPORT DRIVE
AIRWAY HEIGHTS
SPOKANE INTERNATIONAL AIRPORT
SPOKANE RIVER
LATAH CREEK
I-90
NINE MILE RD
ASSEMBLY ST.
DIVISION ST
NEVADA ST
CRESTLINE ST.
MARKET ST.
ARGONNE RD
HAYFORD RD.
3B
3C
6
12
15
16A
16B
18
19
20
22
26
33C
34
34A
34B
39
40
41
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ES-26

- In conjunction with the preparation of CSO basin plans, investigate potential I/I source reductions. From the investigation will follow the design of recommended improvements to reduce I/I in the specific basins. These recommended improvements will then be implemented.

- Replace all active CSO regulating structures to provide accurate measurement and control of discharges to the interceptor system. Existing structures are old and difficult to control and monitor. A long-term monitor will be installed at CSO regulator 3C to ascertain the effectiveness of BMP implementation in basins 2 and 3C.

- On-site retention swales in selected locations in eight CSO basins will be constructed. A new long-term flow monitor will be installed at CSO regulator structure 15 to evaluate the effectiveness of the flow reduction project at that site.

- Construct the on-site detention facility for CSO basin 23 identified in the CSO reduction schedule.

Better on-site control will reduce flows received by combined sewers by intercepting runoff from impervious areas and inflow prior to reaching the combined sewer system. At the completion of Phase 1, an estimated 12 MG of animal CSO reduction will be achieved at a cost of $5.1 million.

ES.8.3.2 Phase 2

The remaining projects in the CSO reduction schedule will be re-evaluated using information from the evaluation of the effectiveness of the Phase 1 projects. Planned studies to be conducted at this time include the following:

- Analyze flow monitoring records from monitors installed during the first phase.

- Based on analysis of first phase project results, calculations for the remaining CSO basin plans and control projects will be revised.

Completion of the second phase studies will update the CSO reduction effort to enhance cost effectiveness in achieving regulatory goal.

ES.8.3.3 Phase 3

Projects and costs estimated for this phase are contingent upon the reduction achieved following completion of the first and second phases. Continued monitoring of CSO regulating structures and the interceptor system will be critical to evaluating the success of the Phase 1 and 2 projects. Major projects associated with the third phase include:

- Preparation of the remaining six basin plans for CSO regulating structures discharging CSO more than once per year

- Construct two remaining on-site retention facilities and separations in selected CSO basins as identified in the CSO reduction schedule

- Replace the remaining regulating structures and implement I/I reduction plans for the remaining CSO basins

- Construct pipe connecting the existing storm line above CSO regulator 20.

- Upgrade the interceptor system. These upgrades will include increasing pipe diameters to accommodate projected flows due to optimization, storage and future development within the City sewer service area. The proposed interceptor upgrades are shown in Table ES-10.

- Increase the treatment plant capacity. The estimated costs associated with this upgrade reflect current regulatory requirements. These requirements may change, affecting the cost of modifications. Foreseeable treatment plant improvements include additional influent flow measurement, bar screens and grit chambers. Additional storage capacity would be needed. The feasibility of these upgrades for treatment plant operations will require further study.

- Optimization of existing interceptor capacity will include modification of six regulating weirs. Monitoring will continue at the regulator 23 site to assess the effectiveness of regulator modification. These regulators were selected because the dynamic interceptor model indicates that one overflow per year is achievable at these sites through optimization alone, and there is baseline data from the November, 1991 monitoring effort. The increase in peak storm flow to the interceptors resulting from the optimization of these regulators is 5.2 mgd. Model runs show that the additional individual peak flows from these sources will be attenuated to an undetectable level at the time of peak flow to the treatment plant.

The estimated reduction in annual overflow volume by the completion of Phase 3 is 18 MG per year. The projected annual CSO volume at that time will therefore be under 60 MG per year, or 10.5 percent of the annual CSO discharge prior to 1983. Of the 30 CSO regulators in 1992, 14 will overflow once per year or less by the completion of Phase 3. Of the 24 CSO outfalls in 1992, 11 will discharge once per year or less by the completion of Phase 3. By the end of Phase 3, an estimated $14.5 million will be expended for CSO reduction projects.

TABLE ES-10. INTERCEPTOR UPGRADES

Location	Manholes	Length (in feet)	Diameter (in inches)	Capital Cost ($1,000)
North River Interceptor	02030-Headworks	11,240	60	3,103
Surro to Greene on South Riverton	05087-05064	6,489	21	576
Hamilton Bridge to East Trent site	05015-05009	3,184	66	1,274
Ohio Avenue Interceptor	02046-02042	1,486	27	177
Summit & Sherwood to Nettleton & Bridge	37212-37201 37015-37010	819	21	252 82
Columbia Circle	24001-24000	114	15	10
Cedar & Ide	36001-36000	23	15	2
Total		23,355		5,476

ES. 8.3.4 Phase 4

As with the Phase 3, projects and costs for Phase 4 are contingent upon the reduction achieved following the implementation of the previous phases. Those projects selected on a preliminary basis for Phase 4 include the following.

- The CSO Reduction Plan will be revised for a second time to reflect changes in the City and information collected during the first 20 years of CSO Reduction effort. At the time of this revision, final planning will be done for Phase 4.

- Construct the storage facilities identified in the CSO reduction schedule, as modified following the second revision of this plan.

- Continue monitoring as necessary to ensure compliance with regulatory requirements.

- If necessary, construct new primary clarifiers to handle increased loads at the SAWTP.

The estimated reduction in annual overflow volume from all CSO reduction projects in the Plan, Phases 1 through 4, is 70.2 MG per year. The resulting annual CSO volume will be 8.40 MG per year, and all CSO outfalls will have a discharge frequency of one event per year or less by the completion of Phase 4. The estimated cost to complete the reduction projects in this Plan is $40 million.

1

1

BOVAY NORTHWEST

CHAPTER 1. INTRODUCTION

1.1 PURPOSE

The purpose of this Plan is to address through compliance action the Revised Code of Washington (RCW) 90.48.480 which requires the control and reduction of combined sewer overflows (CSOs) for the City of Spokane. Through the implementation of this Plan, the City of Spokane will achieve compliance with state and federal water quality criteria that are related to CSOs. This Plan quantifies and describes the quality of remaining CSOs from the City of Spokane's sewerage system, and defines and prioritizes a program for reducing CSOs to the Spokane River and its tributaries in the City of Spokane. This comprehensive planning document addresses flow reduction strategies for the city's combined sewer collection system. This document does not necessarily satisfy the requirements of a detailed, site specific engineering report. Proper implementation of this Plan will result in basin plans for site specific projects for CSO reduction in each of the City's CSO collection basins. The preparation of this report is in compliance with federal and state water quality regulations.

1.2 REGULATORY BACKGROUND

In 1985 Washington State adopted RCW 90.48.480, requiring municipalities to prepare CSO reduction plans. The Washington State Department of Ecology (Ecology) established a plan (Washington Administrative Code [WAC] 173-245) to implement this statute. Specific elements of the Ecology requirements are given in WAC 173-245-040, CSO Reduction Plan (see Appendix A), including:

- Documentation of CSO activity
- Analysis of control/treatment alternatives
- Analysis of selected control/treatment projects
- Priority ranking of selected projects and control strategies
- Proposed schedule for achieving compliance with the CSO reduction section of the State Environmental Policy Act (SEPA).

1.2.1 Definition of CSO

There are 30 combined sewer regulators in the City of Spokane's wastewater collection system. A regulator is a structure controlling the overflow of wastewater to an outfall

to a natural water body. There are several outfalls that have more than one contributing regulator structure. Outfalls are numbered from downstream to upstream, consistent with an historical numbering system. As a result of continuing the historical numbering system, the numbers of outfalls no longer in use have been dropped from the system. Regulating structures are identified with the outfall number and, if there is more than one regulating structure to an outfall, a letter is assigned following the outfall number. Figure 1-1 shows the location of the CSO outfalls. Table 1-1 describes the location of each CSO outfall.

1.2.2 Discussion of State Regulations

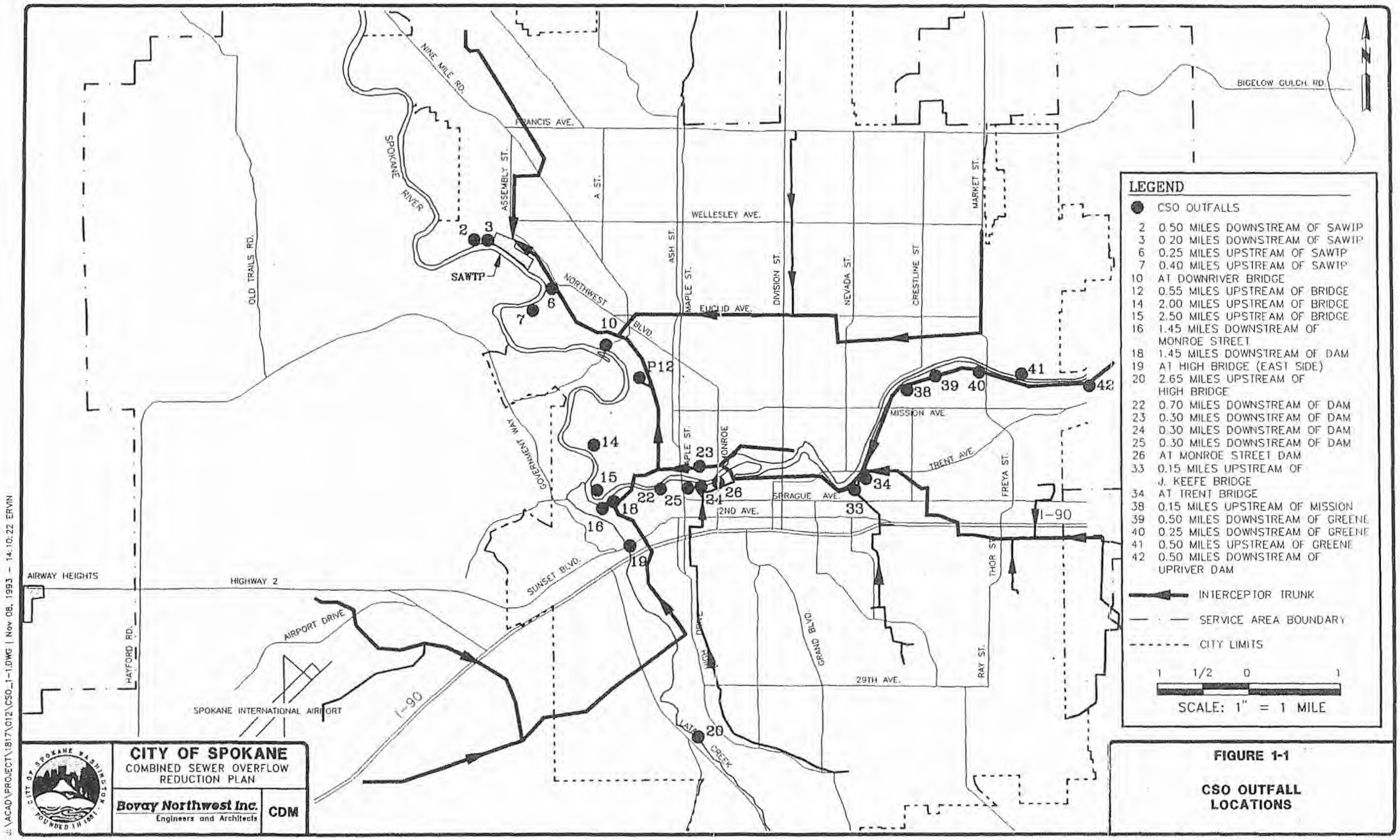
The contents of this CSO Reduction Plan are governed by Washington State regulation WAC Section 173-245-040. References to "Ecology" requirements and standards are construed to mean "Washington State" requirements and standards.

The WAC 173-245 regulation establishes guidelines for meeting the legislature's requirement for "the greatest reasonable reduction of combined sewer overflows at the earliest possible date." The interpretation of this requirement is that each CSO shall be controlled "such that an average of one untreated discharge may occur per year." To plan for meeting this requirement, a CSO reduction plan is required in accordance with WAC 173-245-040. The first step in preparing a CSO reduction plan is documentation of CSO activity. The next steps are to model CSO activity, analyze control alternatives, and recommend a schedule of feasible control projects.

Flow monitoring of CSO sites, according to the WAC, may be conducted "at one or more CSO sites in a group which are in close proximity to one another... [Which] shall be sufficient if the municipality can establish a consistent hydraulic and pollutant correlation between or among the group of CSO sites. Sampling may not be required for CSO sites which serve residential basins." This exempted most CSO basins from quality sampling.

WAC 173-245-040 also requires that mathematical modeling will be used to "establish each CSO's location, baseline annual frequency, and baseline annual volume; to characterize each discharge; and to estimate historical impact..." This was done using the Storage, Treatment, Overflow Runoff Model (STORM).

The STORM and Storm Water Management Model (SWMM) were used to fulfill the WAC 173-245 requirement for analysis of control and treatment alternatives. The objective of this requirement is to identify the control/treatment alternatives that will achieve the greatest reasonable reduction at each CSO site.



SPOKANE-PRR-2379430

TABLE 1-1. COMBINED SEWER OVERFLOW REGULATOR OUTFALL LOCATIONS

Outfall Number	Outfall Location	Overflow Regulator Locations and Description
Spokane River Discharges (North Bank)		
002	0.5 miles downstream of SAWTP[1]	Hartley at NW Blvd. - LW[2]
003	0.2 miles downstream of SAWTP	B. Assembly at NW Blvd. - Albi - Dam[3] C. Assembly at NW Blvd. - Royal Ct. - LW
006	0.25 miles upstream of SAWTP	Kiernan at NW Blvd. - LW
007	0.4 miles upstream of SAWTP	Columbia Circle at NW Blvd. - LW
010	At Downriver Bridge	Cochran at Buckeye - Side[4]
012	0.55 miles upstream of Bridge	Nora at Pettet Dr. - LW
014	2.0 miles upstream of Bridge	Sherwood at Summit - LW
015	2.5 miles upstream of Bridge	Ohio at Nettleton - LW
016	1.45 miles downstream of Monroe St. Dam	A. "A" at Linton - Geiger - LW B. "A" at Linton - West Grove - LW
018	1.45 miles downstream of Dam	"A" at Linton - Federal - LW
Discharges to Hangman Creek		
019	At High Bridge (East Side)	Seventh at Cannon - Side
020	2.65 miles upstream of High Bridge	S. Manito Relief Sewer - Side
Discharges to Spokane River (South Bank)		
022	0.7 miles downstream of Dam	Main at Oak - Dam
Discharge to Spokane River (North Bank)		
023	0.3 miles downstream of Dam	Cedar at Ide - LW
Discharges to Spokane River (South Bank)		
024	0.3 miles downstream of Dam	Cedar at Riverside - LW Cedar at Riverside - Side
025	0.3 miles downstream of Dam	Cedar at Main - Dam
026	At Monroe Street Dam	Lincoln at Spokane Falls Blvd. - Dam

TABLE 1.1 COMBINED SEWER OVERFLOW REGULATOR OUTFALL LOCATIONS (cont.)

Outfall Number	Outfall Location	Overflow Regulator Locations and Description
033	0.15 miles upstream of J. Keefe Bridge	A. Fifth at Arthur - LW B. Third at Perry - Side C. Third at Arthur - LW D. First at Arthur - LW
034	At Trent Bridge	Crestline at Riverside - Dam
038	0.15 miles upstream of Mission	Magnolia at S. Riverton - LW
039	0.5 miles downstream of Greene	Altamont at S. Riverton - LW
040	0.25 miles downstream of Greene	Regal at S. Riverton - LW
Discharge to Spokane River (North Bank)		
041	0.5 miles upstream of Greene	Rebecca at Upriver Dr. - LW
Discharge to Spokane River (South Bank)		
042	0.5 miles downstream of Upriver Dam	Surro Dr. - Side

1. SAWTP = Spokane Advanced Wastewater Treatment Plant.
2. Leaping weir overflow regulator.
3. Transverse weir or dam overflow regulator.
4. Side-overflow regulator.

The selected treatment/control projects are then further assessed for impacts to receiving water quality, impacts to treatment facilities, cost effectiveness, construction and operation practicality, and compliance with the SEPA.

1.2.3 Control/Treatment Alternatives

The following is a list of control/treatment alternatives. These alternatives were considered for each CSO and are addressed within the CSO Reduction Plan.

- "Use of best management practices, sewer use ordinances, pretreatment programs, and sewer maintenance programs to reduce pollutants, reduce infiltration and delay, and reduce inflow (WAC 173-245-040, 1987)."

- "At least primary treatment and disinfection at the secondary sewage treatment facility which is served by the combined sewer (WAC 173-245-040, 1987)," shall be considered. Primary treatment at the Spokane Advanced Wastewater Treatment Plant (SAWTP) is considered for both non-storage (the existing condition) and storage scenarios.

- Increased sewage treatment capacity at the SAWTP for at least primary treatment and disinfection is considered.

- At-site primary treatment in conjunction with off-line storage and at-site primary treatment alone are considered.

- Complete and partial storm sewer separation are considered.

1.2.4 Application of WAC 173-245

Since 1983, when the City of Spokane initiated a 6-year storm sewer separation construction program, CSO volume into the Spokane River and its tributary system has been reduced by an estimated 86 percent (1992 Calculations, see Table 1-2) at a construction cost of $43 million (1992 dollars). Sixty-four percent of the City of Spokane's developed sewer service area was separated by 1990. Most of these separations were outlined in the *1977 Facilities Planning Report for Sewer Overflow Abatement* (City of Spokane, 1977). These separations have reduced estimated CSO volume by a total of 491 million gallons (MG) per year (Table 1-2). The areas with separate storm sewers are shown in Figure 1-2.

TABLE 1-2. ELIMINATED COMBINED SEWER OVERFLOW[1]

CSO Location	CSO[2] Regulator No.	Annual Overflow (MG)[3]	Overflow Frequency (annual)
NW Blvd. at Assembly[4]	3A	58.46	47
Cochran at Grace[4]	9	411.10	44
Monroe at Bridge[5]	27	1.53	20
N. End of Howard St. Bridge[5]	28	2.90	37
N. End of Washington St. Bridge[5]	29	5.75	23
Astor at Desmet[5]	30	0.08	10
Front at Erie[5]	31A	0.08	3
Front at Erie[5]	31B	10.91	20
Mallon at Perry[5]	35	0.43	59
Total System Reduction		491.24	86.3%
Pre-1983		569.4	

1. Totally eliminated by 1990.
2. CSO = Combined Sewer Overflow.
3. MG = Million Gallons.
4. Overflow volume and frequency estimated in 1992.
5. Overflow volume and frequency estimated in 1972 *Action Plan*.

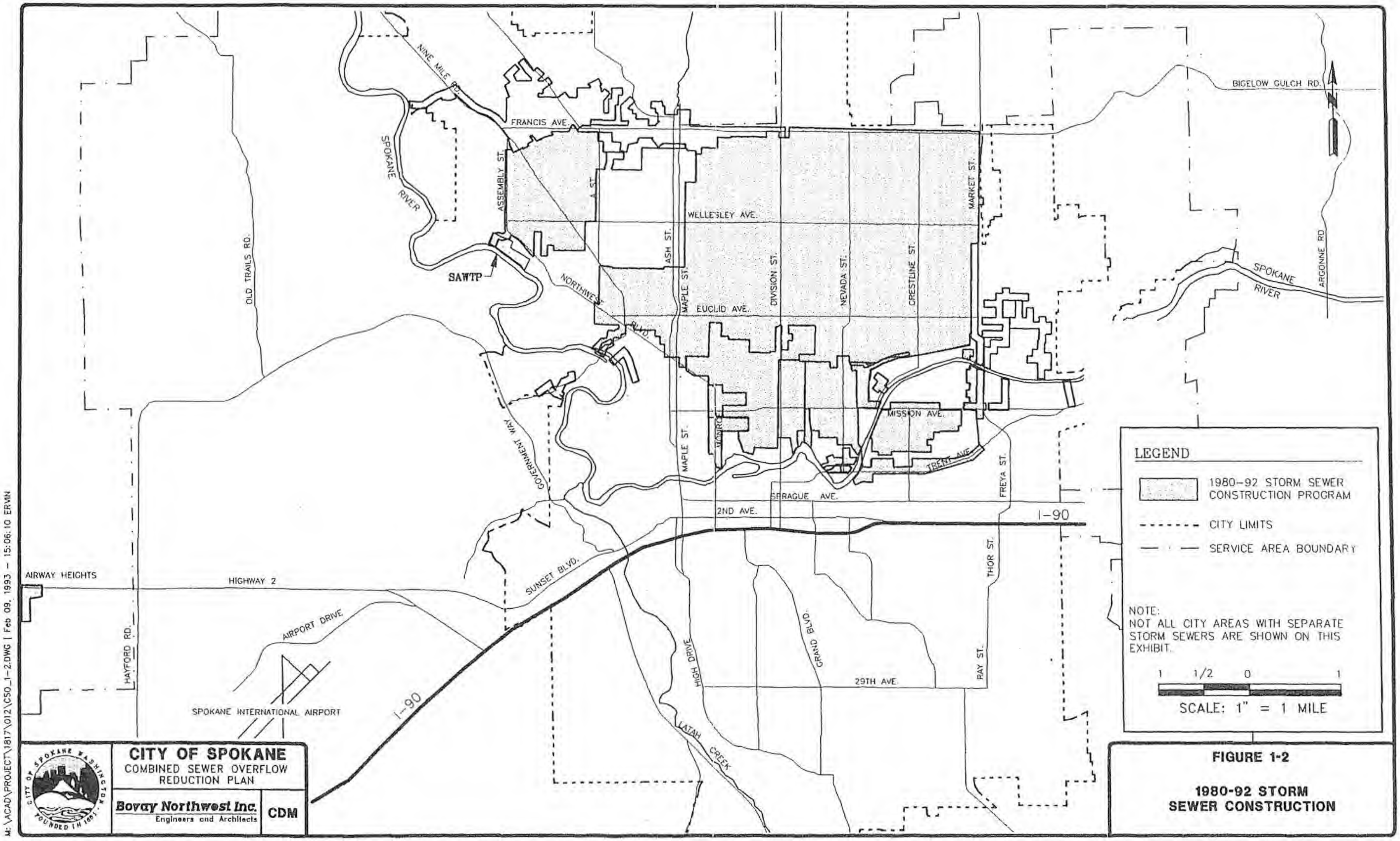


FIGURE 1-2

1980-92 STORM SEWER CONSTRUCTION

The WAC 173-245 requires that each CSO be controlled "such that an average of one untreated discharge may occur per year". One interpretation of "average" in the foregoing statement is that compliance for each CSO is achieved when that site overflows to receiving waters only during storms with a return period of at least 1 year. However, there is a significant practical problem with this approach. Storms of relatively small magnitude may occur on consecutive days, causing discharge from a combined sewer storage system sized for a 1-year storm.

The one event per year interpretation proposed by the City of Spokane is that compliance will be achieved when the maximum discharge frequency for each CSO outfall is an average of one per year.

The City of Spokane intends to achieve or exceed the goal of reducing combined sewer overflow frequencies to one event per year per CSO outfall. Practically, however, this goal must be achieved over an extended period primarily because of the high cost of modifying the existing combined sewer system. This goal will be consistent with the financial capacity of the City of Spokane as stated in WAC 173-245-040 (2)(e)(ii), and is defined in Chapter 8 of this CSO Reduction Plan.

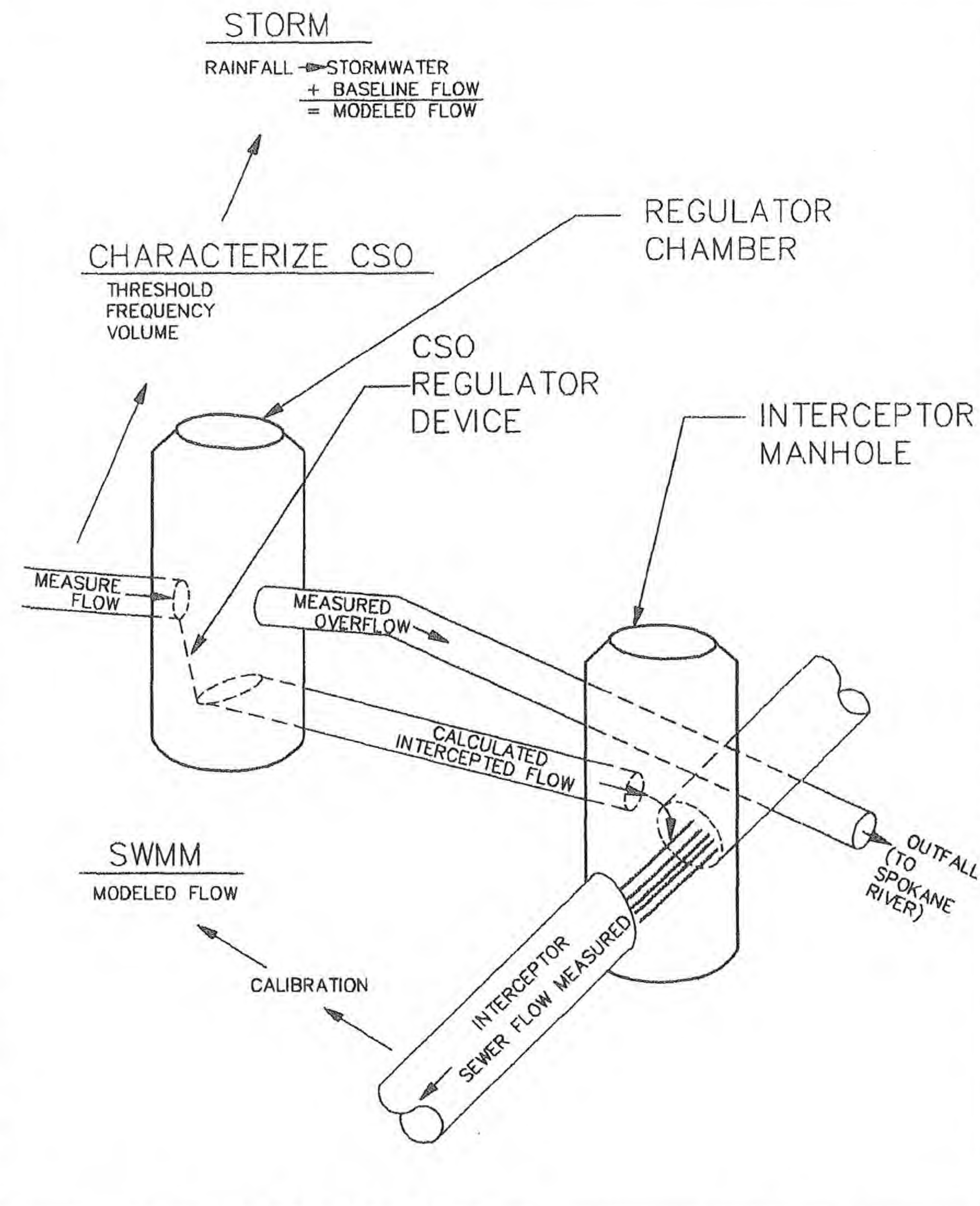
1.3 SCOPE OF WORK

The City of Spokane CSO Reduction Plan study includes a combined sewer overflow and interceptor flow monitoring program, system modeling, alternative solution analysis, and control project recommendations for CSO reduction.

The monitoring program consisted of two major efforts, long-term and short-term monitoring of CSOs, interceptors, and rainfall. The Monitoring Plan (Appendix B) was developed to aid in implementing the monitoring program and describes why and how each major effort was carried out.

Using data collected during the short-term monitoring period, CSO frequency and volume were determined using the STORM, a model developed by the U.S. Army Corps of Engineers Hydraulic Engineering Center (HEC) (HEC, 1979).

A dynamic simulation model, known as SWMM, was customized for the Spokane interceptor system and run to simulate the interaction of CSOs and the interceptor system during wet weather (SWMM was developed by the U.S. Environmental Protection Agency [EPA], 1988). The model was first calibrated to actual measured flows, and then adjusted for the CSO characteristics found by modeling with STORM. STORM and SWMM are described in more detail in Chapter 4 of this CSO Reduction Plan. Figure 1-3 illustrates the relationship between monitored and modeled flows.



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CITY OF SPOKANE WASTEWATER FACILITIES PLAN		**FIGURE 1-3**
Bovay Northwest Inc. Engineers and Architects	**CDM**	**RELATIONSHIP OF MONITORED AND MODELED FLOW**

With STORM and SWMM calibrated to the existing conditions in the combined sewer system and interceptor system, CSO control and treatment alternatives were analyzed. Storage requirements were analyzed with the STORM. The effects of separation, weir setting changes, and interceptor capacity changes were modeled with dynamic flow simulations using the SWMM.

The control and treatment alternatives were identified and organized for evaluation and analysis of their effectiveness in reducing CSO. CSO reduction is directly related to the goals outlined in WAC 173-245, *Submission of Plans and Reports for Construction and Operation of CSO Reduction Facilities*. This analysis resulted in the overall program presented in this Plan to reach the stated goals.

1.4 PLAN ORGANIZATION

This CSO Reduction Plan is organized into eight chapters and a number of appendices. This first chapter includes introductions to the applicable regulations and the philosophy under which this Plan has been written. The general organization of the remainder of this Plan is as follows.

Chapter 2, Service Area Characteristics, describes the natural environment and human environmental influences, including population dynamics, and social, economic, and historical factors.

Chapter 3, Existing Wastewater Collection System, outlines the extent and general condition of the existing wastewater collection system.

Chapter 4, Characterization of Combined Sewer Overflows, characterizes the water quality, volume, and frequency at specific combined sewer overflow regulators. The characterization is the result of the application of the regulations highlighted in Chapter 1 to the combined sewer system model analyses and select water quality data. The characterization is supported by specific information on the computer models used in preparing the Plan, including the modeled depiction of the collection system and CSOs.

Chapter 5, Combined Sewer Overflow Control Technologies, describes control/treatment technologies and their general implications.

The final three chapters lead to the selection of control/treatment projects. Chapter 6, Criteria for Evaluation and Analysis of Control and Treatment Alternatives, lists the criteria used to screen each control/treatment alternative at each CSO regulator or group of CSO regulators.

Evaluation of Control and Treatment Alternatives, Chapter 7, first describes the identified alternatives for each basin and then summarizes the screening evaluation, consistent with the process described in Chapter 6.

The recommended control/treatment projects are presented in Chapter 8, Control and Treatment Projects. This chapter describes the implementation program in detail, and presents a project schedule reflecting a consistent, methodical approach to achieving reduction goals. The costs presented in the project schedule were considered in determining the project sequence and schedule.

2

2

BOVAY
NORTHWEST

CHAPTER 2. SERVICE AREA CHARACTERISTICS

A general description of the City of Spokane sewer service area's characteristics is provided here in order to better understand the context of the CSO reduction effort. Figure 2-1 illustrates the area boundaries served by the City.

2.1 NATURAL ENVIRONMENT

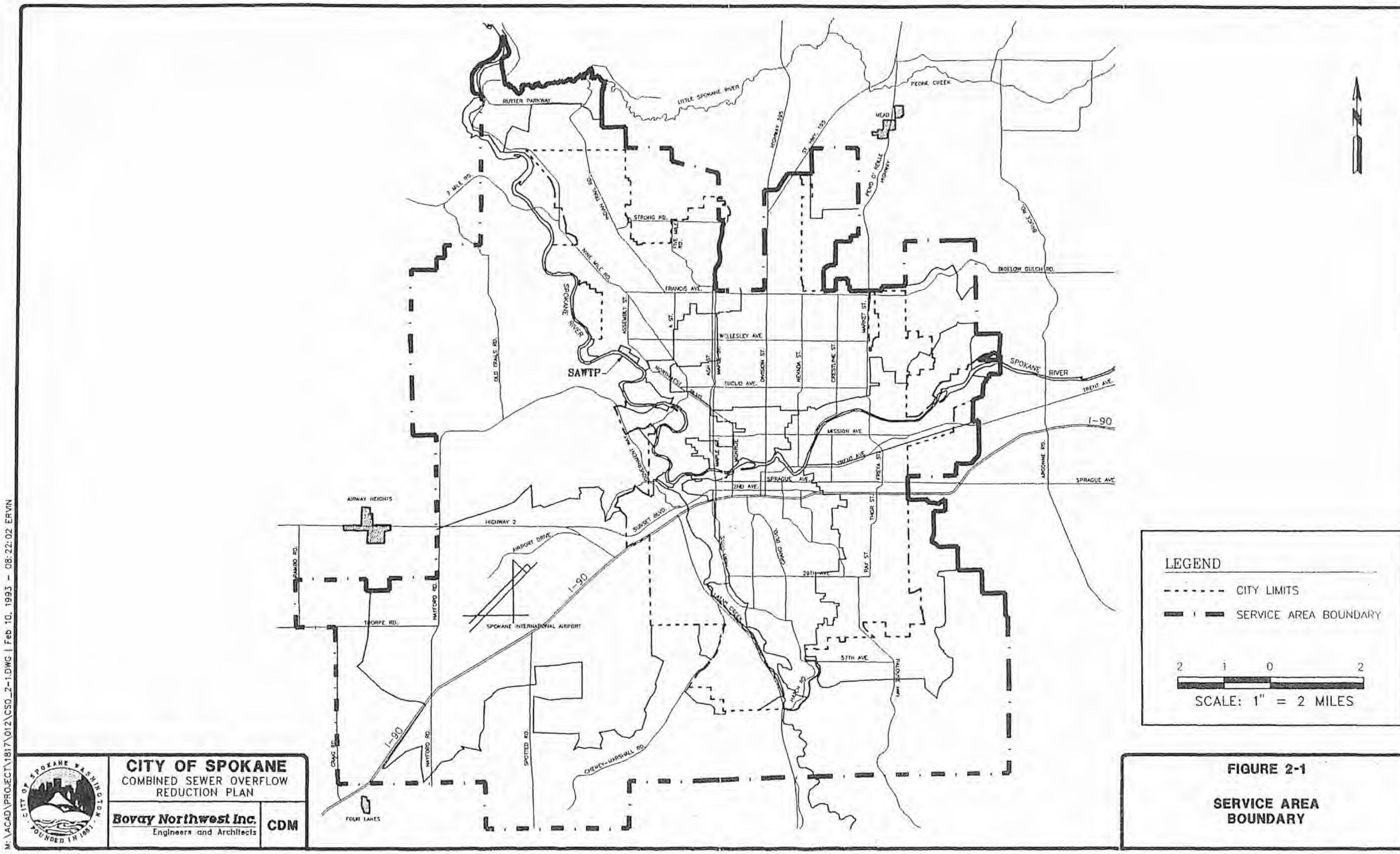
This subsection provides information regarding the physical characteristics of the Plan area.

2.1.1 Geological and Hydrogeological Characteristics

Granitic and metamorphic basement rock underlay the entire Spokane area. The basement rock is covered by lacustrine materials consisting of siltstones, claystones, sandstones, and minor amounts of conglomerate. Individual lava flows, 50 to 150 feet thick, are also found in the area. Basalt outcrops are common throughout the area.

Below the mesas and high ridges of the Spokane Valley, the surface material consists of well-sorted silts and sands with some intermixed clay lenses and gravel. Glacial fluvial deposits are found along the Spokane River and portions of the Little Spokane River. These deposits are composed of clays, sands, gravel, and cobblestones. Recent alluvial deposits of silts, sands, and gravel are found along the Little Spokane River and some of its major tributaries. See Figure 2-2 for a geological map of the area.

The Spokane River basin is the dominant geologic feature of the Spokane area. The largest perennial tributaries of the Spokane River are Latah Creek in the south and the Little Spokane River in the north. A waterfall in the center of the City over basaltic rock divides the river into two hydrologic basins. East of the falls, the river originates at Lake Coeur d'Alene and flows through three reservoirs. West of the falls, the river flows through a series of rapids cutting a canyon lined by basalt cliffs and steep hills until it reaches Nine Mile reservoir.



CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN

Bovay Northwest Inc. Engineers and Architects | CDM

FIGURE 2-1

SERVICE AREA BOUNDARY

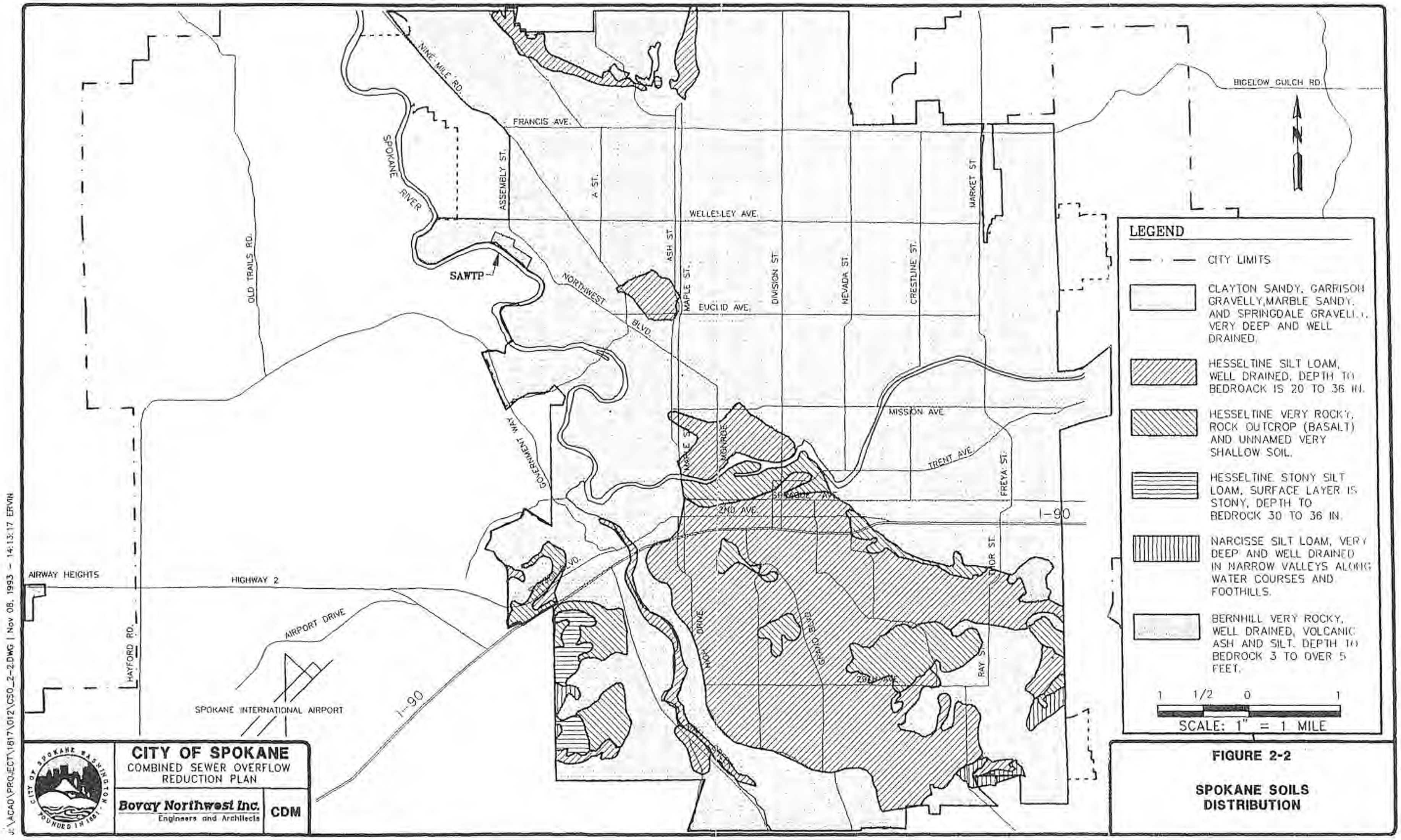


FIGURE 2-2

SPOKANE SOILS DISTRIBUTION

In addition to the Spokane River, surface water includes the Little Spokane River, which flows into the Spokane River about two miles north of the city limits; Latah Creek, which flows from the south joining the Spokane River west of the City; Marshall Creek which flows into Latah Creek near Marshall Road; an unnamed creek which also flows into Latah Creek; and scattered ponds and wetlands areas. Most of the ponds and wetlands are found in the South Hill area around the Manito Park-Lincoln Park area and south of 29th Avenue. A significant part of southeast Spokane along with Moran and Glenrose Prairies experience problems of seasonal standing surface water which has restricted development in these areas (City of Spokane, 1983, 1990B).

The Spokane-Rathdrum Aquifer lies in eastern Washington and northern Idaho. It extends from Pend Oreille and Coeur d'Alene Lakes through the Spokane Valley and exits as springs into the Spokane River between Sullivan Road and the Post Street Dam near the Little Spokane River. The aquifer covers over 350 square miles and supplies water for over 340,000 people. The Plan area is located over the western-most portion of the aquifer. The aquifer lies between 40 and 150 feet below the surface in the Spokane area.

2.1.2 Water Quality and Quantity

The EPA has designated the Spokane-Rathdrum Aquifer as a sole source aquifer (see Figure 2-3). The quality of the groundwater, at present, is suitable for domestic, municipal, commercial, agricultural, and industrial use. Ground over the aquifer is highly permeable making the aquifer susceptible to contamination by certain substances spilled or placed on the ground in the immediate drainage area.

The Spokane River was given a "Class A" designation by Ecology (WAC, 1991). This classification requires that the river meet or exceed the conditions required for all beneficial uses.

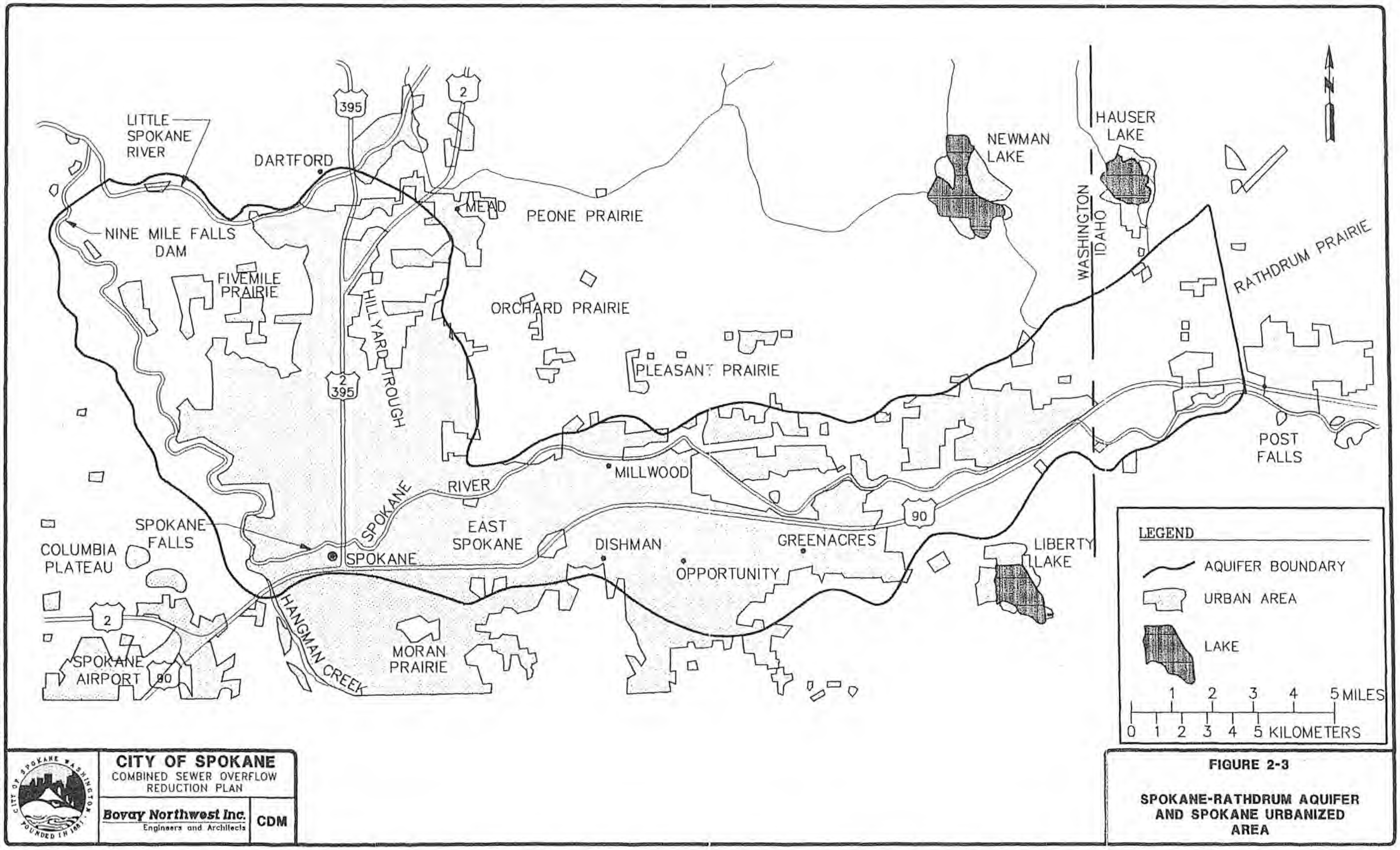


FIGURE 2-3

SPOKANE-RATHDRUM AQUIFER AND SPOKANE URBANIZED AREA

A year long fecal coliform survey was carried out over a 63 mile stretch of the river from the Washington-Idaho border to Long Lake Dam (Merrill, 1986). According to the study, the river met its Class A criterion for fecal coliform during dry weather, but values often increased by a thousand fold following major storm events or snow melt. Furthermore, according to the most recent River Study performed by the Eastern Washington University (EWU) biology department, analysis of wet weather CSO samples indicate that CSOs continue to impact the Spokane River (Soltero et al, 1990). The quality of the Spokane River was significantly lowered below the Trent Street Bridge by the discharge of CSO during wet weather. From the limited amount of data available at the time of the River Study, the CSOs at Riverside at Napa/Crestline (CSO 34), Lincoln at Spokane Falls Boulevard (CSO 26), and Nora at Pettet Drive (CSO 12) appear to impact river quality during wet weather (Bovay Northwest, 1991A).

Priority pollutant scans performed on wet weather samples were found to be free of volatiles, non-volatiles, polychlorobiphenyls, and pesticides. Some metals, primarily zinc, were evident at both of the metal sample sites and are probably from past mining operations near Kellogg, Idaho. Bioassays using three kinds of organisms were conducted to determine the quality of the treatment plant effluent and the river water quality above and below the treatment plant outfall. Survival of test organisms was 100 percent for all three sites using full-strength samples (Soltero et al, 1990).

The major sources of pollutants in the upper Spokane River are several industrial source point dischargers and the Liberty Lake, Post Falls, and Coeur d'Alene municipal wastewater treatment plants. As the river flows through the urbanized Spokane area the nutrient load increases. Effluent from the Spokane wastewater treatment plant contributes to the river's nutrient load (Spokane County, 1981) (Harper Owes, 1985). The nutrient rich Latah Creek and Little Spokane River also have a significant effect on the Spokane River's total nutrient load. The Spokane Soil Conservation District under the United States Department of Agriculture (USDA) has attempted to allocate the non-point nutrient loading to the Spokane River. Ecology has constructed a phosphorus attenuation model that also attempts to allocate non-point phosphorus loads (Koch, 1993). There have been no documented cases of fish kills due to poor water quality (Soltero personal communication, 1990). Details of this study can be found in Appendix C.

According to the Spokane County Public Health Department, there have been documented on-site sewage system failures in the Spokane area. Failure was defined as surfacing sewage. There are three reasons for the failures, (1) premature failures due to soils conditions, (2) age of on-site systems, and (3) inadequate maintenance of the system which is the leading cause statewide. The areas that have experienced documented failures include the Glen Eden addition north of Wandermere Lake bordered by Cincinnati Drive; the Linwood area between Division and Wall north of Francis up to and including Country Homes; and the Five Mile area along the hill bordered by Wall street.

According to the Department, most of these failures are due to a combination of poor soils and the age of the system. There are also areas that have experienced on-site sewage system failures in the service area boundary. These areas are targeted for extension of sewer services in the *Six-Year Comprehensive Sewer Program, 1993 through 1998* (City of Spokane, 1992A). See Appendix D.

2.1.3 Sediment Quality

Spokane River sediment quality was examined by Soltero in 1989. Twenty-one of the 24 remaining CSOs outfalls were inspected during the survey. Outfalls 38, 39, and 40 could not be specifically located after an extensive search and, therefore, were not examined. Sediment samples were taken at seven outfalls (CSO outfalls 2, 3, 6, 7, 23, 34, and 42). The sediments were primarily silts and gravels normally found in the river. No sludge deposits were observed at any site. Some solidified tar was evident in the pipe or in close proximity to CSO outfalls 6, 22, and 25 (Soltero, et al, 1990). More in-depth analysis, including chemical analysis, is in Section 4.3.2.

2.1.4 Floodplains and Wetlands

Floodplains and wetlands within the City limits generally follow the Spokane River. The floodplain is well controlled by upstream dams and is generally confined by relatively steep banks through the City. There are several ponds scattered among the parks on the South Hill, including Cannon Hill, Manito, and Lincoln. Drumheller Springs is also within the City limits. In addition, there is a large drainage area in the Moran Prairie area which results in seasonal ponds and wetlands.

2.1.5 Fish and Wildlife

The local reach of the Spokane River supports stocked brown and rainbow trout. Self-sustaining populations of bass, crappie, and perch are also found. Long Lake is best known for its large mouth bass fishery. Other fish found in Long Lake include yellow perch, crappie, bluegill, northern squawfish, tench, and green sunfish.

Big game animals within the study area include mule deer, whitetail deer, and black bear. Small animals including muskrat, mink, beaver, and racoon can be found mainly along the Spokane and Little Spokane rivers.

The most common upland game bird found in the area is the ruffed grouse. Other species include quail, ring-neck pheasant, mourning dove, and partridge. Mallard and Canadian geese are the most common waterfowl in the area. Ducks and geese use Long Lake as a migratory resting area, and herons use the lower Little Spokane River marshes for nesting. The croplands in the area provide food for the nesting birds.

Three species of animals have been identified by the National Fish and Wildlife Service as "candidate" threatened or endangered species. These are the Swainson's hawk, long-billed curlew, and snowy plovers. Occasionally bald eagles, an officially listed endangered species, can be found within the study area.

2.2 HUMAN ENVIRONMENTAL INFLUENCES

2.2.1 Population and Socioeconomic Conditions

The City of Spokane had a 1990 estimated population of 177,126 compared to a 1980 population of 171,300. The Spokane economy is heavily based on service industries and wholesale and retail trade. The City is the largest between Seattle and Minneapolis and between Calgary and Salt Lake City. Due to its size and location, Spokane serves as a "hub" and provides services to a region of 36 counties, encompassing parts of Montana, Oregon, Idaho, British Columbia, Alberta, and Washington. Approximately 1.5 million people reside within this trade zone (Spokane Facts, 1990).

Historically, most of the economy in the Spokane area relied on the natural resource sectors of forest products, agriculture, and mining. While these continue to be important elements of the area's economy, Spokane has diversified significantly with the influx and growth of high technology firms and service industries. The unemployment rate in the Spokane area ranged between 8.3 percent and 6.5 percent during the decade from 1980 through 1989 (Spokane Facts, 1990).

2.2.2 Land Use and Development

The land use pattern has been substantially established in the City. Very little remains undeveloped, with the exception of the far southwest quadrant west of Latah Creek. Those areas, and other portions of the City that have not been developed, contain development constraints such as steep slopes and rocky soils. In 1990, there were approximately 25,000 acres of developed land within the corporate limits of Spokane with the following land uses:

Land Use	No. of Acres
Residential	19,495
Commercial	2,934
Industrial	1,440
Point Loads	118
Parks, Golf Courses and Schools	1,021
Total	25,008

Within the City limits, there are limited areas zoned for agriculture. The parcels are located along Latah Creek and on Five Mile Hill. There are also some large vacant land parcels. The total area of agricultural and vacant land within the City limits is about 5,000 acres.

2.3 HISTORY OF WASTEWATER MANAGEMENT

The City of Spokane (originally Spokane Falls) was first settled in the 1870's. The first sewer was laid as a combined storm water and sanitary system in Howard Street from First Avenue to the River. During the 1890's, the area from the lower South Hill to the River between Cedar and Division streets was sewered. The sewer system expanded as the City grew, and the number of discharge points along the river increased. By the 1920's, raw sewage could be seen in the river, especially following heavy rainfall (Fahey, 1986). Many of the sewer lines constructed in the late 1890's and early 1900's are still in use today.

2.3.1 Year 1909 to 1962

The Washington State Department of Health in 1909 and 1929 ordered the City to cease and prevent any further dumping of sewage into the river. In both cases, the City took no action and the State did not pursue the matter. Riverine sludge deposits, low dissolved oxygen levels, and pathogenic hazards were linked to the raw sewage discharges along the river in the 1930's. The 1933 Pearse, Greeley & Hansen *Report on Sewage Disposal* recommended construction of an interceptor system to convey sewage flow to a proposed wastewater treatment plant (Pearse et al, 1933). At that time, there were 22 active municipal sewer outlets to the Spokane River, releasing a daily average of 14 million gallons per day (mgd). About 50 percent of the City's population was served by sewers; the rest utilized cesspools and vaults.

Bond issues in 1933 and 1937 to install intercepter and transmission lines to a wastewater treatment facility were defeated. It was not until 1952 that Spokane passed a bond issue for a facility (McDonald, 1978). The City completed construction of the sewer system and its primary wastewater treatment plant in 1958. Although the plant was doing the job for which it was designed, during wet weather events or long periods of snow melt, hydraulically overloaded collection pipes were relieved by allowing raw wastewater to flow into the river. This plant was upgraded in 1962 to include one more clarifier and sludge digesters.

2.3.2 Year 1962 to Present

The *1972 Action Plan* addressed the State of Washington requirement that Spokane upgrade the treatment plant to at least secondary treatment from the then existing primary treatment level. This led to the planning, design, and construction of the present SAWTP facility, built around the older primary treatment plant.

Combined sewers were originally built within the City because they allowed for reduced capital construction costs. Since pipes and treatment facilities large enough to handle the volume of sanitary sewage (dry weather flow) plus any possible amount of storm water (wet weather flow) were too expensive, overflow (CSO) points to surface waters were usually constructed to prevent system backups and protect treatment plant operations. The frequency and volume of overflow is dependent on system capacity and duration and intensity of storms. During periods of heavy rainfall or snowmelt, Spokane had experienced hydraulic overloading at its primary treatment plant. Excess raw sewage and storm water had to be released into the river at the treatment plant and at 33 other outfalls (CSOs). In the 1960's, there were as many as 45 CSO locations, some with an overflow frequency up to 140 times a year (Esvelt and Saxton/Bovay Engineers, 1972).

In accordance with the *1979 Facilities Planning Report for Combined Sewer Overflow Abatement*, the City's approach to CSO abatement is phased (Bovay Engineers, 1979). The first phase was completed in January 1990 with the construction of separate storm sewers in two large northern drainages which eliminated 86 percent of the estimated CSO volume that annually reached the river. This phase was completed at a cost of approximately $43 million. The second phase of CSO reduction is defined in this CSO Reduction Plan. This plan is required by Ecology and will be in place in 1993.

3

3

BOVAY
NORTHWEST
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CHAPTER 3. EXISTING WASTEWATER COLLECTION SYSTEM

This Chapter provides a description of the existing sanitary sewer collection system, the existing storm drainage system, the current status of the City's CSO regulating structures, the land uses in the areas tributary to CSOs, and the current City policy regarding CSOs.

3.1 CITY SEWER COLLECTION SYSTEM

The City of Spokane manages over 800 miles of sewer line serving a population of 177,126 (1990 Census). The City system includes:

- 290 miles of sanitary sewers
- 130 miles of storm sewers
- 400 miles of combined sewers
- 14,000 catch basins/dry wells
- 22 pumping stations
- 26 outfalls with National Pollutant Discharge Elimination System (NPDES) permit, including 24 CSO outfalls
- 30 combined sewer overflow regulating structures.

Figure 3-1 shows the major combined sanitary interceptor lines within the City service area.

The City of Spokane operates 22 sewage lift stations and maintains 11 major inverted siphons (sag pipes). Pertinent facilities are shown on Figure 3-2. The lift stations and inverted siphons are identified in Table 3-1. The City is currently in the process of upgrading all lift stations. The improvements will include adding "dialers" to the stations for telemetry; providing standby emergency power; and wiring changes. The City has allotted $20,000 per year for these upgrades. In addition, the City now requires that new pump stations have dialers and emergency power.

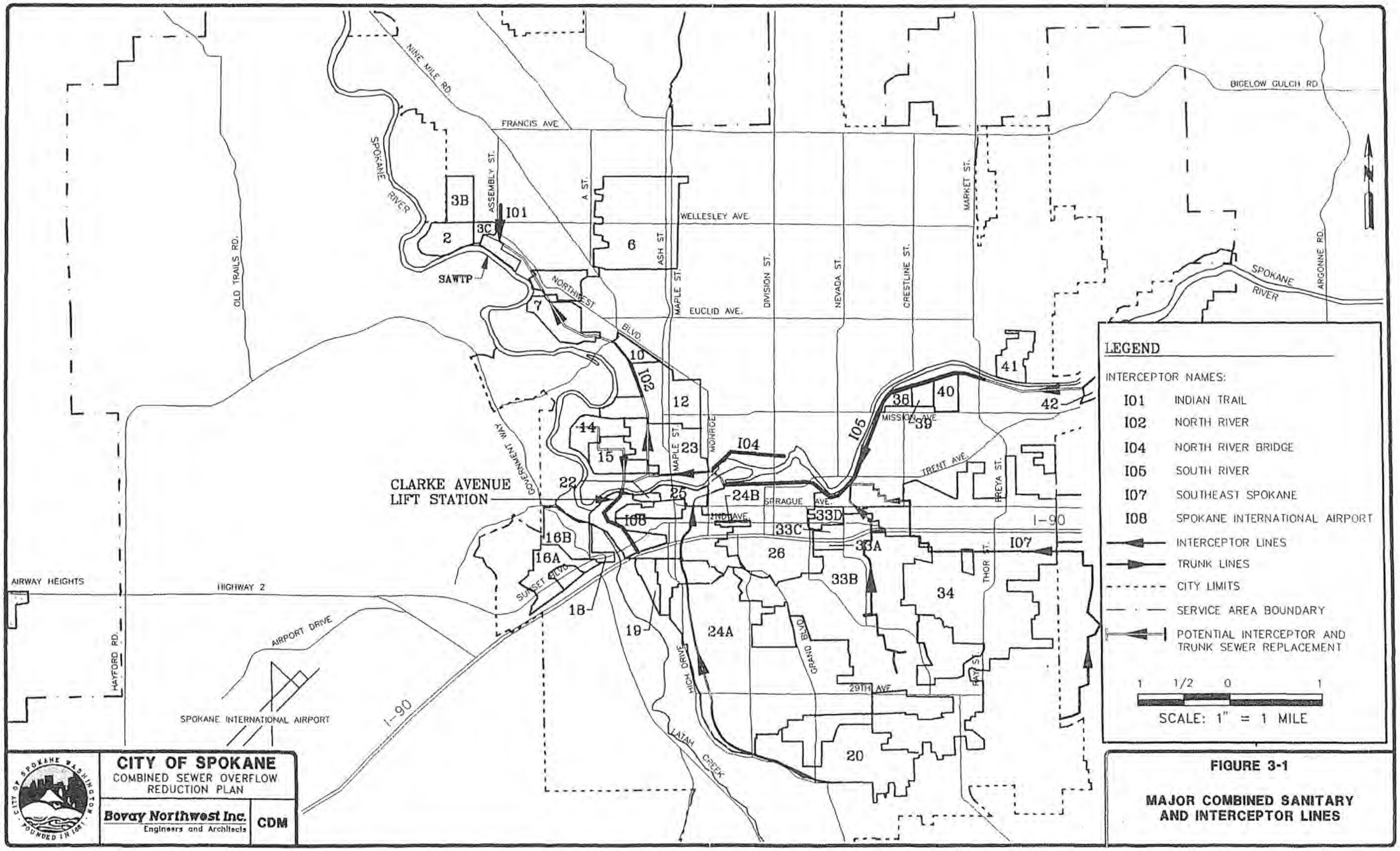
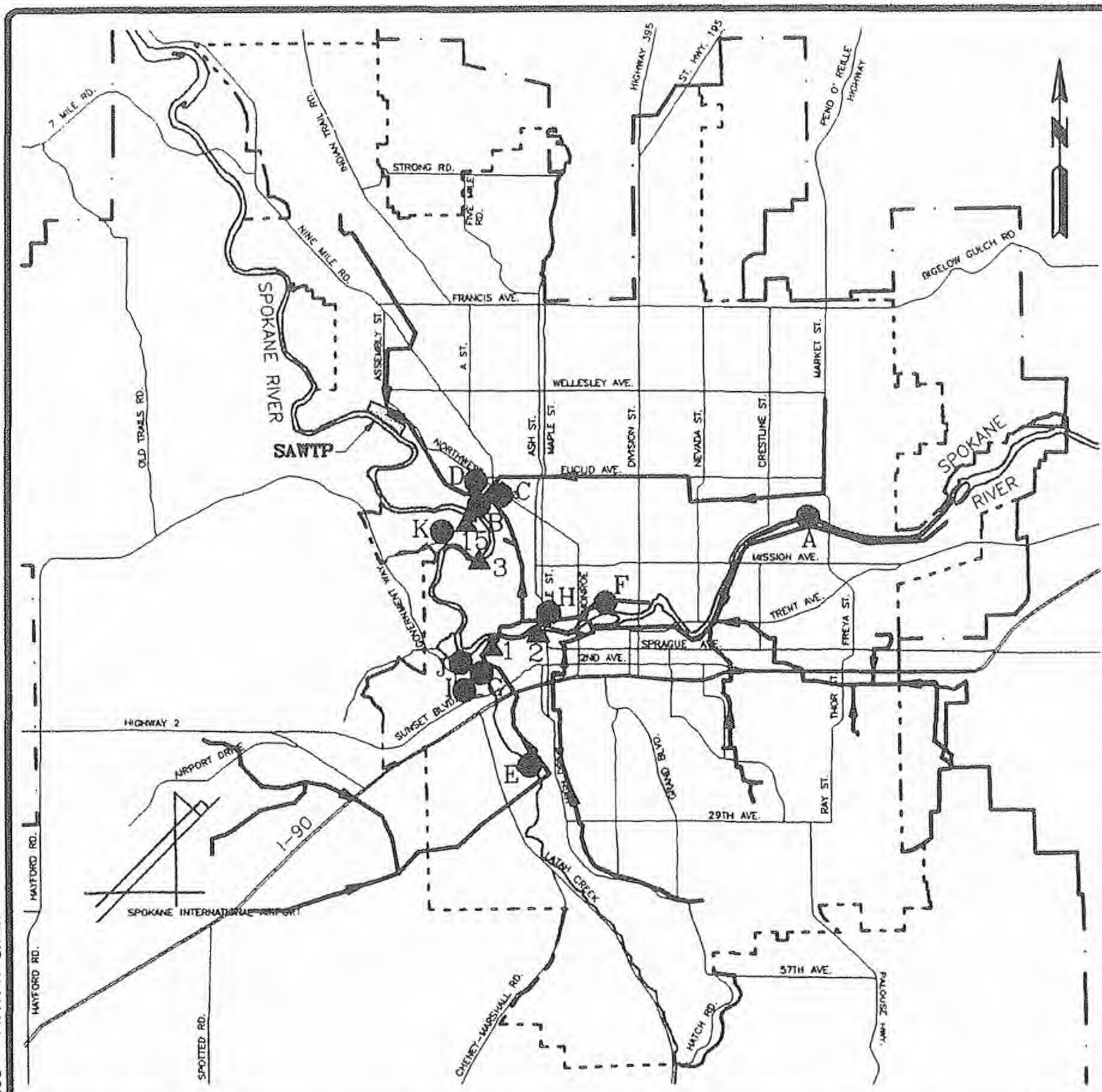


FIGURE 3-1

MAJOR COMBINED SANITARY AND INTERCEPTOR LINES



LEGEND

A ● INVERTED SIPHON

1 ▲ LIFT STATION

------- CITY LIMITS

— · — SERVICE AREA BOUNDARY

NOTES:

1. SEE TABLE 3-1 FOR LIFT STATION AND INVERTED SIPHON IDENTIFICATION.

2 1 0 2

SCALE: 1" = 2 MILES

CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN

Bovay Northwest Inc.
Engineers and Architects

CDM

FIGURE 3-2
INTERCEPTOR AND COMBINED LIFT STATION AND SIPHON LOCATIONS

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TABLE 3-1. COMBINED SEWAGE LIFT STATION AND SIPHON IDENTIFICATION[1]

LIFT STATIONS

LIFT STATION NUMBER	STATION NAME	SEWER TYPE	ADDRESS	YEAR BUILT	NUMBE R OF PUMPS	TOTAL PUMP CAPACITY (GPM)
1	Clarke Ave.[2]	Combined	W. 2414 Clarke	1958	3	5,250
2	Elm Street[2]	Combined	N. 127 Elm St.	1958	2	800
3	San Souci West	Combined	N. 1621 "A" St.	1958	2	300
15	College Complex Ft. Wright	Combined	W. 2903 Ft. Wright	1970	2	150

INVERTED SIPHONS

FIGURE DESIGNATION	LOCATION	MANHOLE INLET #	LENGTH (FT.)	MANHOLE OUTLET #	COMMENTS
A	Regal	5600216	293	5600124	Dual pipes across Spokane River
B	Meenach Dr. Siphon	0202560	400	0202460	Part of the Interceptor 02 under T.J. Meenach Drive
C	Cochran at Buckeye	3000108	387	0300121	Trunk 30 connection to Interceptor 03
D	Cochran Siphon	0300121	586	0202460	Cochran sanitary line connecting to Interceptor 02
E	SIA #1	0803642	266	0803542	Constructed as part of Interceptor 08 under Latah Creek
F	Howard Street	0401436	1,280	0401327	Part of Interceptor 04; North channel of Spokane River
G	Latah Creek & Pacific Avenue	4600310	534	4600215	Victory Heights Trunk 461 under Latah Creek
H	Maple at Bridge	3600518	29	3600418	Under Maple Street Bridge, North
I	Geiger Sewer	4500412	1,000	4500112	Under Latah Creek
J	West Grove	4400736	133	4400610	Under Latah Creek, West Grove
K	Fort Wright	3501308	800	3500108	Under Spokane River

Notes:

1. See Figure 3-3 for locations of lift stations and siphons.
2. Station is equipped with a dialer.

The collection system has 30 remaining CSO regulating structures. These regulating structures discharge through 24 outfall lines during storm events to the Spokane River. After 1990, an estimated 78 MG of untreated combined sewage was discharged into the Spokane River in the average year. From computer simulations in 1992, it is estimated that 570 MG was discharged in the average year prior to 1983.

The City has been reducing CSO discharges by constructing separate storm sewers primarily in the north-central part of the City. To date, the City's CSO reduction program has separated 128 miles of combined sewers into sanitary and storm sewers. The total number of CSO regulators has been reduced from 40 to 30 since 1977.

Figure 3-3 highlights the areas of the City that are still served by combined sewers and outlines areas where separate storm sewers were constructed from 1980 to 1992. The majority of the remaining combined sewer area includes the downtown commercial area and the South Hill area south of Interstate 90 which is detailed in Figure 3-4.

Early sewers were constructed of vitrified clay or cement tile. These early sewers have caused maintenance problems for the City, particularly in the downtown area. In this area there are approximately 4 miles of old pipe with 6-inch lampholes and abandoned service connections. In the downtown area, infiltration/inflow (I/I) is also a major issue due to the old construction, unused service connections, and deteriorating condition of the sewers.

With the advent of new materials, the City has utilized higher durability pipes. The City requires all new construction to be separate storm and sanitary sewer systems and that new sewer construction be tested and inspected by remote television cameras after installation.

The City Wastewater Maintenance Department oversees the television inspection of new sewers and inspects all sewer construction and repair work. Approximately 7 miles per year of old sewer is inspected by television and added to the City's video database. In addition, the Maintenance Department inspects and cleans catch basins and dry wells an average of once in five years which is as frequently as budget constraints allow. Sewer lines are generally inspected and cleaned every other year. The City maintains and operates a computerized collection management system to plan and coordinate sewer maintenance work.

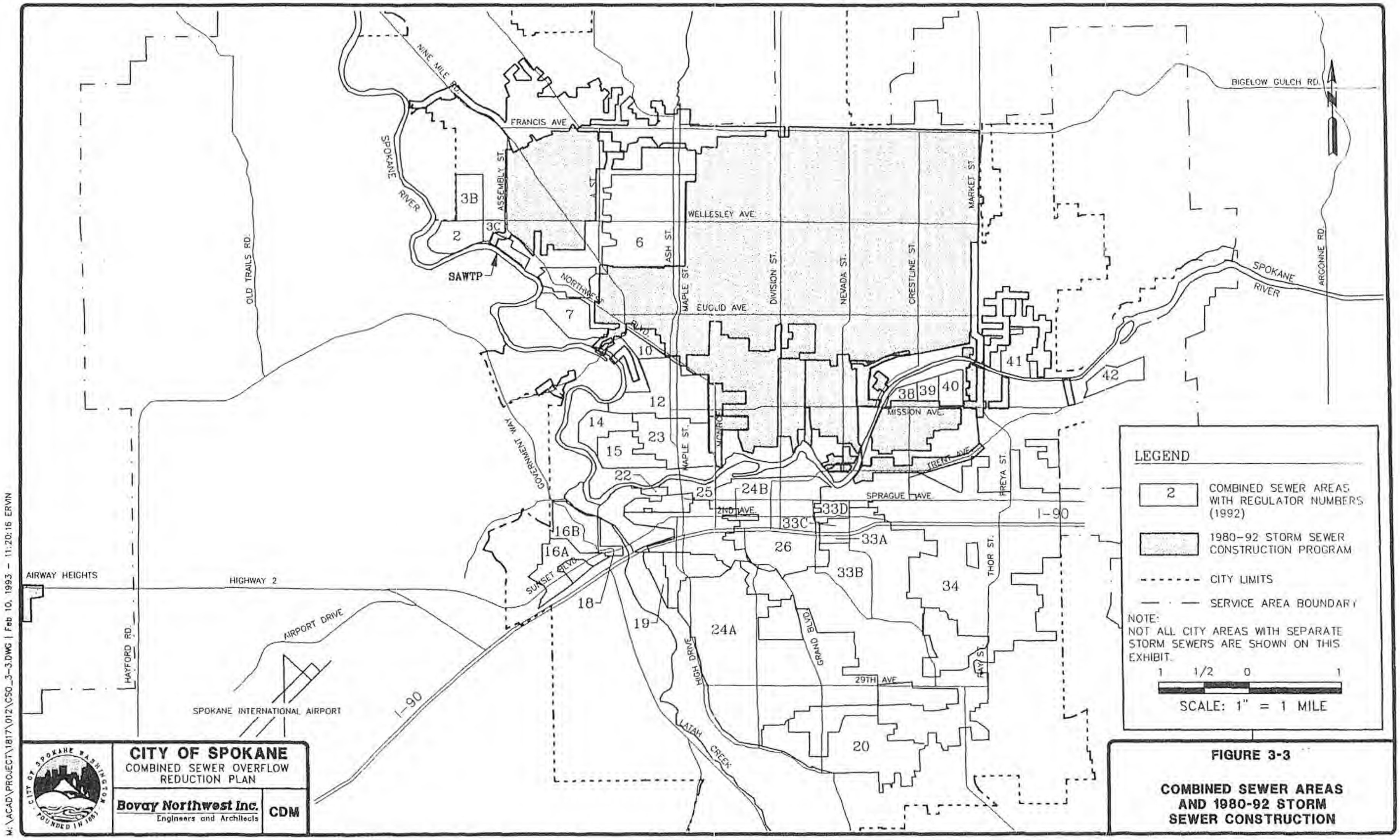
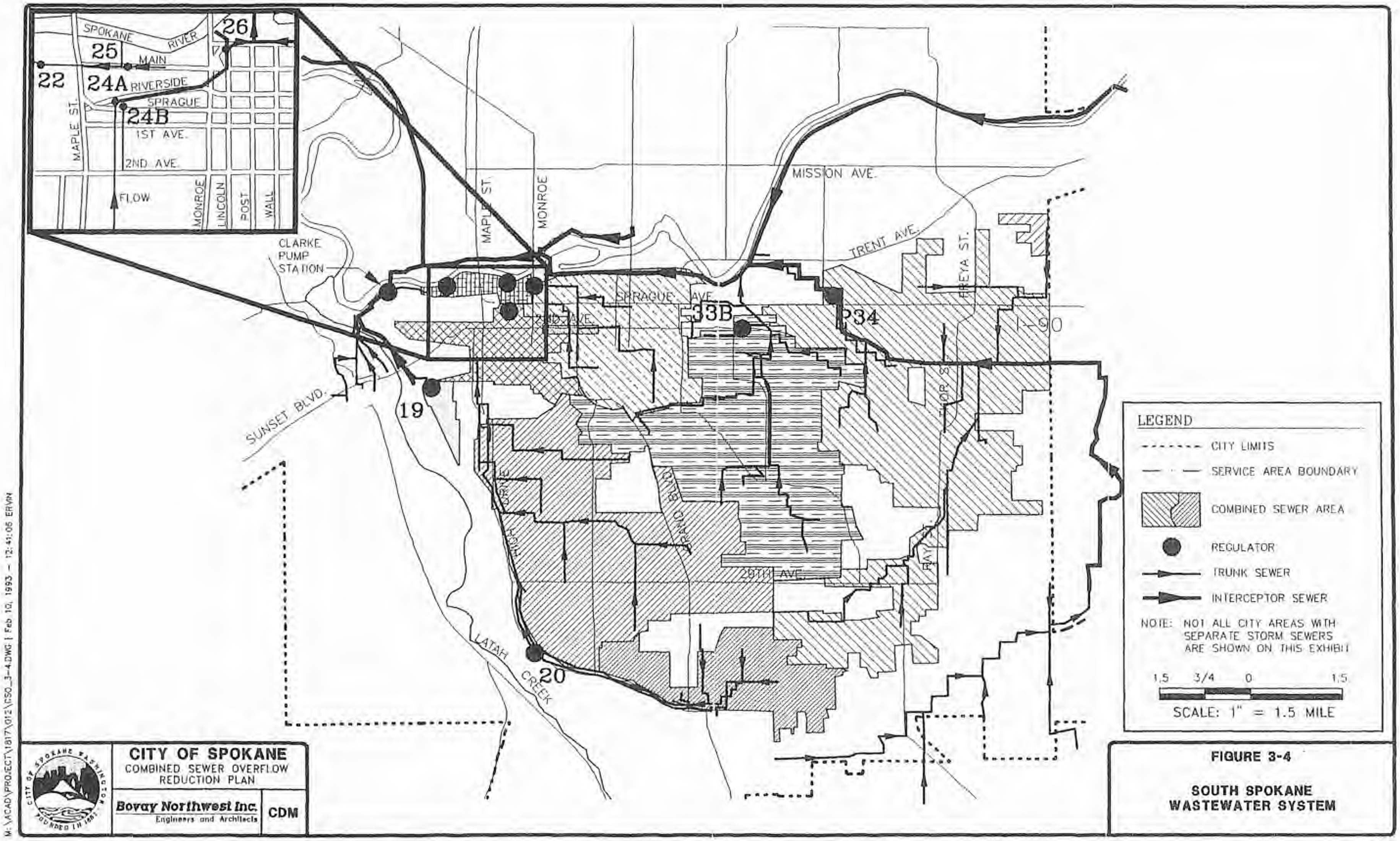


FIGURE 3-3

COMBINED SEWER AREAS AND 1980-92 STORM SEWER CONSTRUCTION



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3.2 STORM DRAINAGE FACILITIES

Storm drainage facilities include roof drains, storm drains, and catch basins which flow into a storm drain pipeline that is separate from the sanitary sewer pipe.

In 1977 the City requested funding for CSO elimination under the Public Law 92-500 grant program, stating that without such assistance the City could not guarantee that it would be able to meet any schedule imposed on it (*Facilities Planning Report for Sewer Overflow Abatement*, City of Spokane Public Works Department, 1977). The highest priority overflows were those discharging at the Meenach Drive outfall for the Cochran and Grace overflow structure and the Hollywood overflow at Northwest Boulevard and Assembly. The elimination of these overflows by 1990 through separation of the upstream basins reduced the estimated annual volume of overflow by 86 percent.

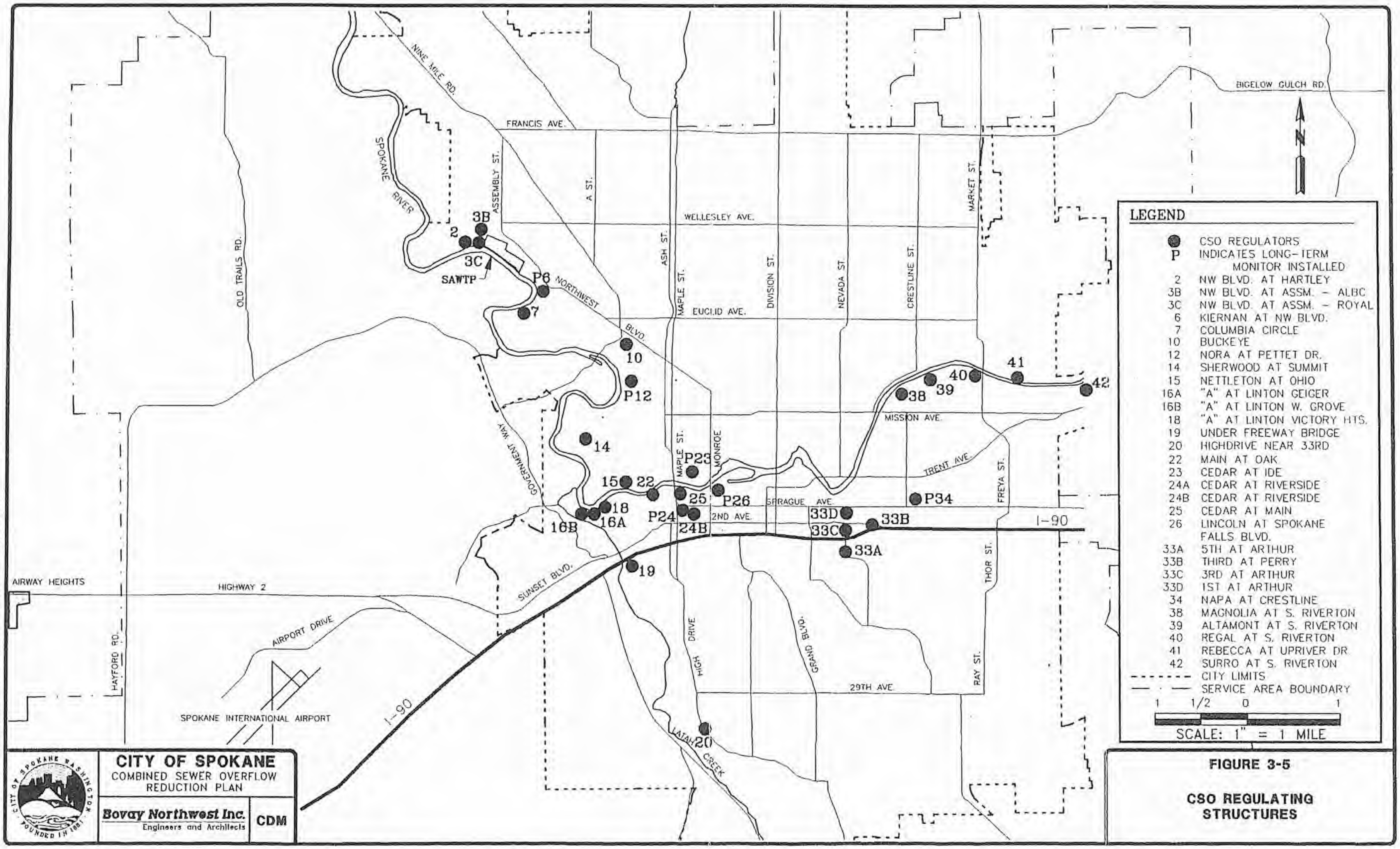
At the time the *1977 Facilities Planning Report for Sewer Overflow Abatement* was written, the City maintained 57 miles of separate storm sewers. Since that time an additional 73 miles of separate storm sewers have been constructed. These sewers are primarily on the north side of the City (see Figure 3-3) There are now 80 storm drainage outfalls in the City storm sewer system, 73 of which discharge to the Spokane River and 6 more that discharge to Latah Creek. The remaining single discharge is to a series of large infiltration basins northeast of Francis Avenue and Maple Street.

In 1977 the area served by separate storm sewers was 2,510 acres, including 560 acres draining to the infiltration basins at Francis and Maple. By 1990, separation of sewers had added another 7,350 acres for a total acreage of 9,860, covering approximately 42 percent of the City's current sewer service area. An additional 4,200 acres of sewered area drain storm runoff to dry wells or other on-site storm water disposal facilities.

Operation and maintenance (O&M) of the City's storm sewer system is funded by sewer service rate payers.

3.3 CURRENT CSO STATUS

The City of Spokane wastewater utility has a total of 26 outfalls on the City's NPDES discharge permit. Of this total, 24 are associated with combined sewers. The location of the CSO overflow structures are illustrated in Figure 3-5. Combined sewer and storm drain outfalls range in size from 10 to 69 inches in diameter and are constructed of clay, concrete, corrugated metal, or cast iron. Lengths of outfall pipe, the pipe from the intercepting manhole to the discharge end of the pipe, range from 65 feet to 4,250 feet.



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The City's CSO outfalls discharge to the Spokane River and to Latah Creek. Outfall structures are arranged along the Spokane river from CSO 42, approximately two-thirds of a mile below Upriver Dam, to CSO 02, which discharges about one-half of a mile below the SAWTP. One overflow structure, CSO 06, discharges through two pipes to one outfall, a 48-inch corrugated metal pipe and a 24-inch reinforced concrete pipe. Two overflow structures, CSOs 3B and 3C, share outfall 003. Two overflow structures, CSOs 16A and 16B, share outfall 016. Two overflow structures, CSOs 24A and 24B, share outfall 024. Four overflow structures, CSOs 33A, 33B, 33C, and 33D all share outfall 033. Two outfalls, from CSO regulators 19 and 20, discharge to Latah Creek. The hydrologic characteristics of each CSO basin are shown in Table 3-2. The relationships of the CSOs to the interceptor sewer system are illustrated in Figure 3-6.

3.3.1 Monitoring

At the time this CSO Plan was prepared, the City was monitoring six CSO structures and four interceptor sites (see Figure 3-5) on a continuous long-term basis and plans to continue this for many more years. In addition, 15 other CSOs were monitored in November, 1991, and 2 more CSOs were monitored in 1989 for short periods of time (30 to 120 days) under the City's Wastewater Facility Plan monitoring effort. The remaining six monitored CSOs have hydrologic characteristics similar to those of adjacent monitored sites and have easily modeled hydraulic diversion structures. Monitoring was conducted as planned in the *CSO Reduction Plan Monitoring, Modeling and Management Plan* (Bovay Northwest, 1991B). Figures 3-7 and 3-8 illustrate the peak interceptor system wet and dry weather flows, respectively.

Figure 3-9 shows the estimated annual volumes and frequencies for each CSO structure. Frequencies range from less than 1 in 10 years for CSO 19 to 58 per year from CSO 03C. The estimated current average annual volume of overflow from all 30 "active" overflow regulators is 78 MG. Volume and frequency were estimated using the STORM.

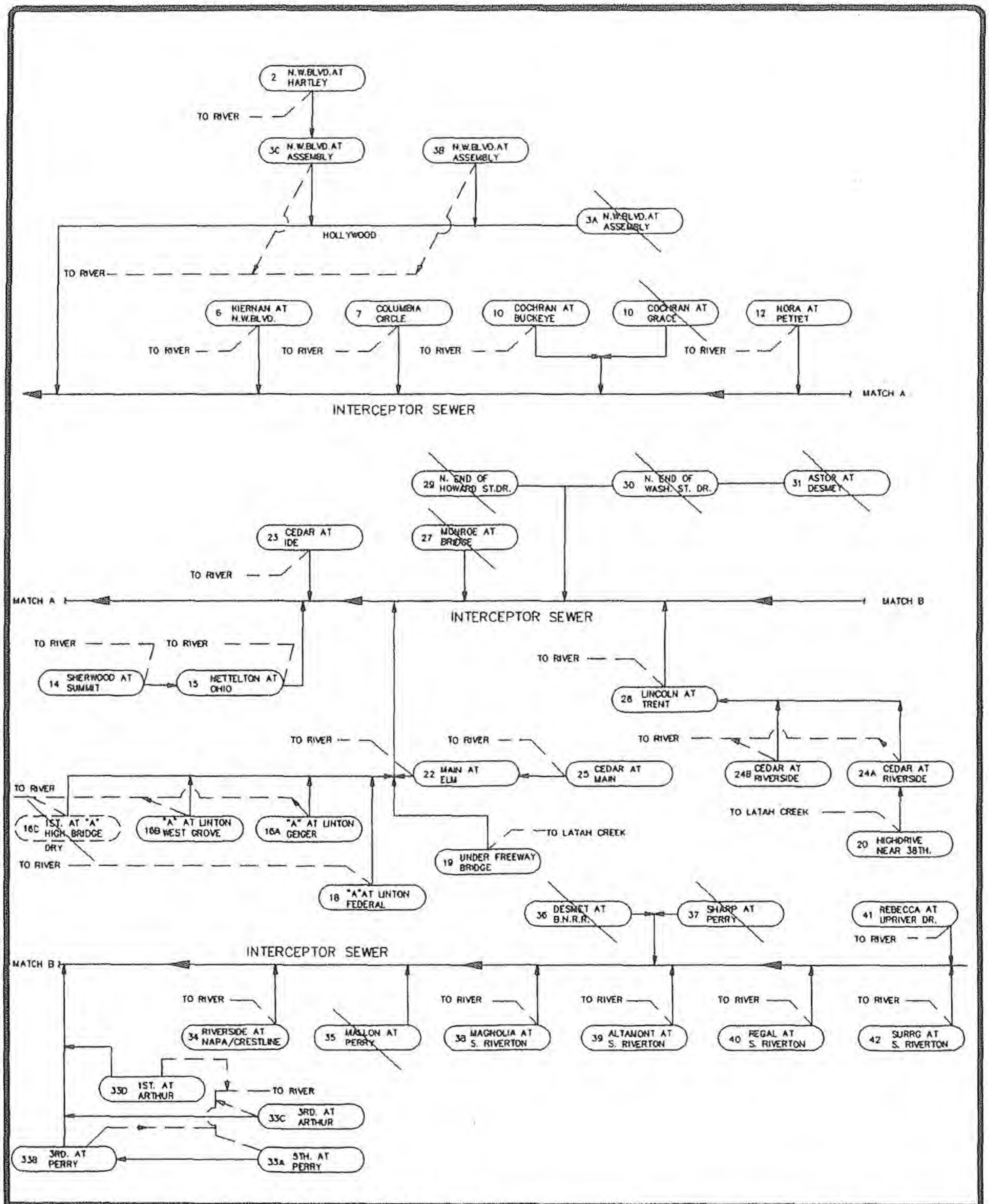
3.3.2 Sewer Backups

A review of city incident data from 1986 through 1991 appears to indicate that there are no combined sewer lines in the City that have chronic backup problems due to storm water runoff. However, future planning and modeling should take incident data into account. Backed-up sewers in a combined sewer area during runoff are indicative of insufficient capacity to handle that runoff quantity. Back-up complaints by homeowners or businesses can aid in identifying capacity problems and serve to help calibrate a collection system model. Such areas are good candidates for detention basin installation, separation, collection system replacement, or other management practice improvements.

TABLE 3-2. CSO BASIN DESCRIPTION AND CHARACTERISTICS

CSO No.	CSO Regulator Location	Basin Area (ac)[2]	Average Sanitary Flow (Measured)[1] (mgd)[3]	Maximum Intercepted Flow (Measured) (mgd)
2	NW Blvd. at Hartley - LW[4]	84	0.054	0.30
3B	NW Blvd. at Assembly (from Albi)- Dam[5]	10	0.039	0.22
3C	NW Blvd. at Assembly (from Royal) - LW	17	0.065	0.47
6	Kiernan at NW Blvd. - LW	619	0.642	2.94
7	Columbia Circle - LW	190	0.141	2.07
10	Cochran at Buckeye - Side[6]	75	0.088	1.06
12	Nora at Pettet - LW	345	0.695	3.80
14	Sherwood at Summit - LW	79	0.096	0.80
15	Nettleton at Ohio - LW	129	0.333	1.97
16A	"A" Street at Linton - LW	56	0.243	2.90
16B	"A" Street at Linton - LW	75	0.258	1.27
18	1st at "A" Street - LW	11	0.079	0.25
19	Under Freeway Bridge - Side	41	0.046	35.40
20	High Drive near 33rd - Side	407	0.189	6.52
22	Main at Oak St. - Dam	38	0.160	2.20
23	Cedar at Ide - LW	168	0.254	2.00
24A	Cedar at Riverside - LW	1,385	3.304	12.20
24B	Cedar at Riverside - Dam[7]	20	N/A	N/A
25	Cedar at Main - Dam	24	0.115	0.59
26	Lincoln at Spokane Falls - Dam	980	12.000	36.80
33A	5th at Arthur - LW	53	0.049	2.00
33B	3rd at Perry - Side	1,256	1.600	19.32
33C	3rd at Arthur - LW	14	0.050	0.45
33D	1st at Arthur - LW	45	0.250	0.76
34	Riverside at Napa/Crestline - Dam	1,409	3.500	13.77
38	Magnolia at S. Riverton - LW	73	0.087	0.69
39	Altamont at S. Riverton - LW	51	0.029	0.28
40	Regal at S. Riverton - LW	56	0.071	0.60
41	Rebecca at Upriver Dr. - LW	87	0.081	1.57
42	Surro at S. Riverton - Side	82	0.330	2.00

1. Measured in 1989, 1990 and/or 1992, except 3B, 3C, 19, 22, 24B, 33A, 33D.
2. ac = acres.
3. mgd = million gallons per day.
4. Leaping weir or dam overflow regulator.
5. Transverse weir or dam overflow regulator
6. Side-overflow regulator.
7. Not monitored or modeled at time of plan.



CITY OF SPOKANE
WASTEWATER FACILITIES PLAN

Bovay Northwest Inc.
Engineers and Architects

CDM

FIGURE 3-6

COMBINED SEWER OVERFLOW SCHEMATIC RELATION TO INTERCEPTOR SEWER

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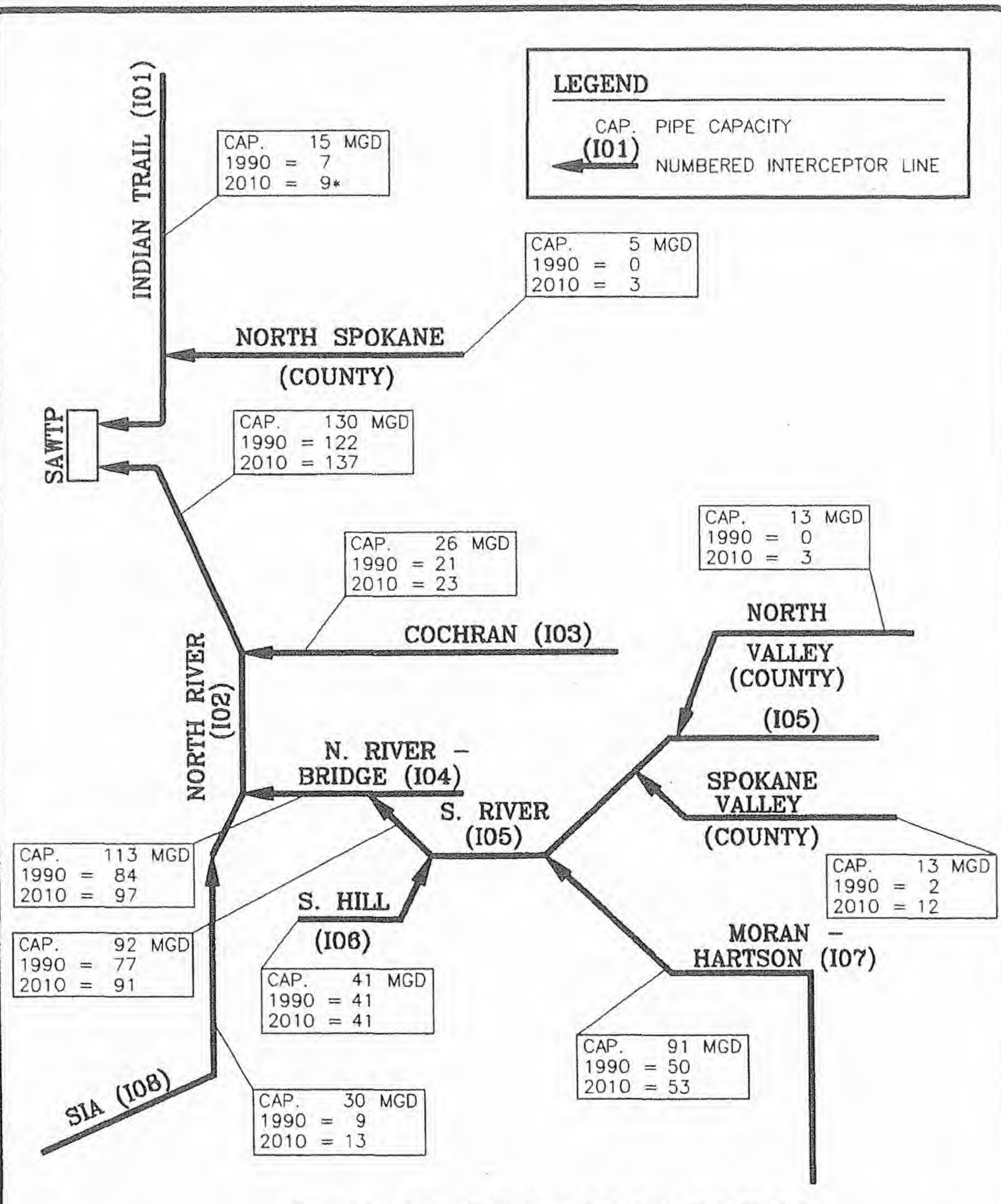

* THIS FIGURE IS LOWER THAN THE DRY WEATHER FLOW DUE TO A HIGH DRY WEATHER PEAKING FACTOR.

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CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN

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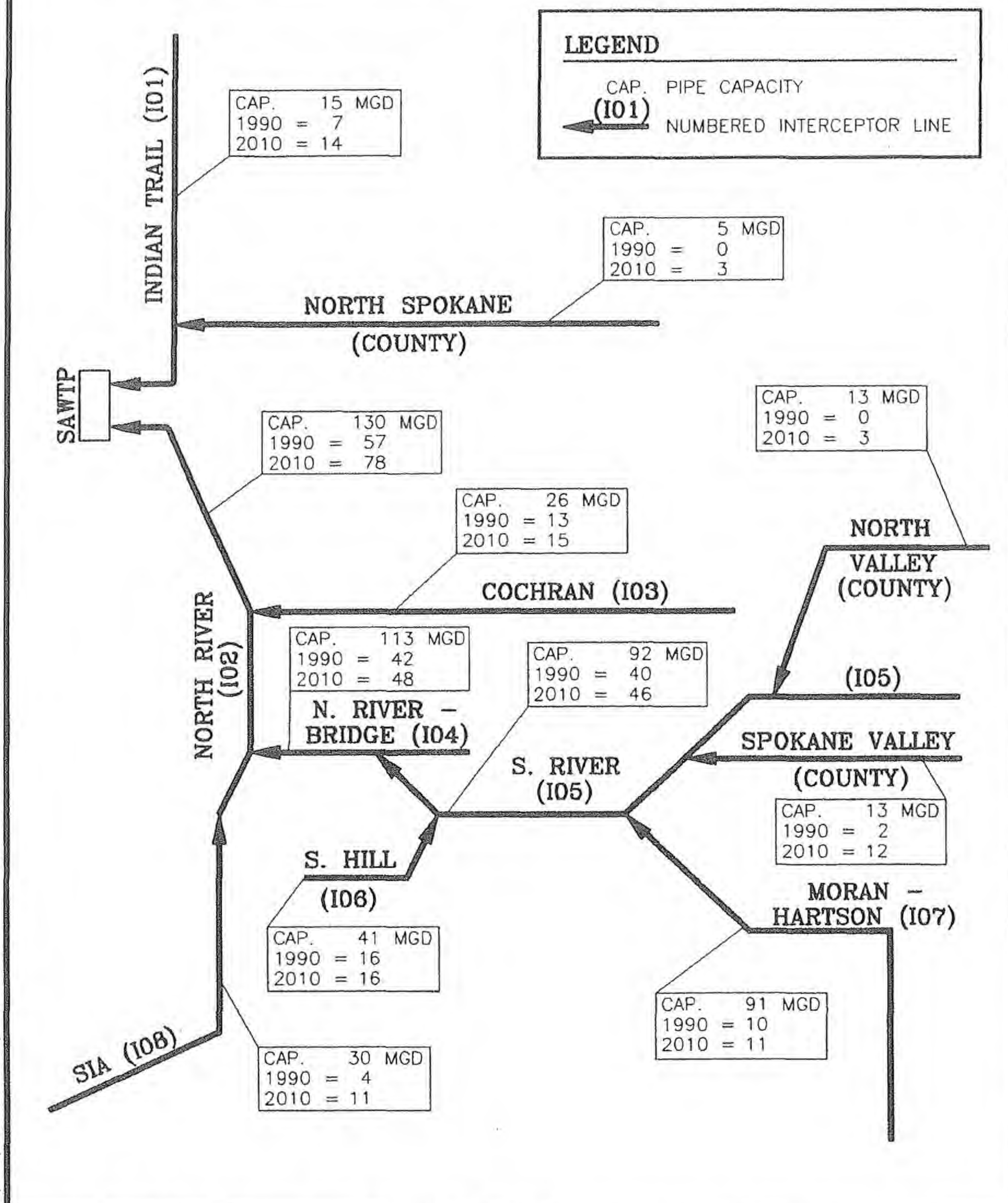
FIGURE 3-7

INTERCEPTOR SCHEMATIC
PEAK 5-YEAR WET WEATHER FLOWS WITHOUT CSO REDUCTION



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CITY OF SPOKANE COMBINED SEWER OVERFLOW REDUCTION PLAN		FIGURE 3-8
Bovay Northwest Inc. Engineers and Architects	CDM	INTERCEPTOR SCHEMATIC PEAK DRY WEATHER FLOWS

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CITY OF SPOKANE · WASHINGTON · FOUNDED IN 1881

CITY OF SPOKANE

COMBINED SEWER OVERFLOW REDUCTION PLAN

Bovay Northwest Inc.
Engineers and Architects

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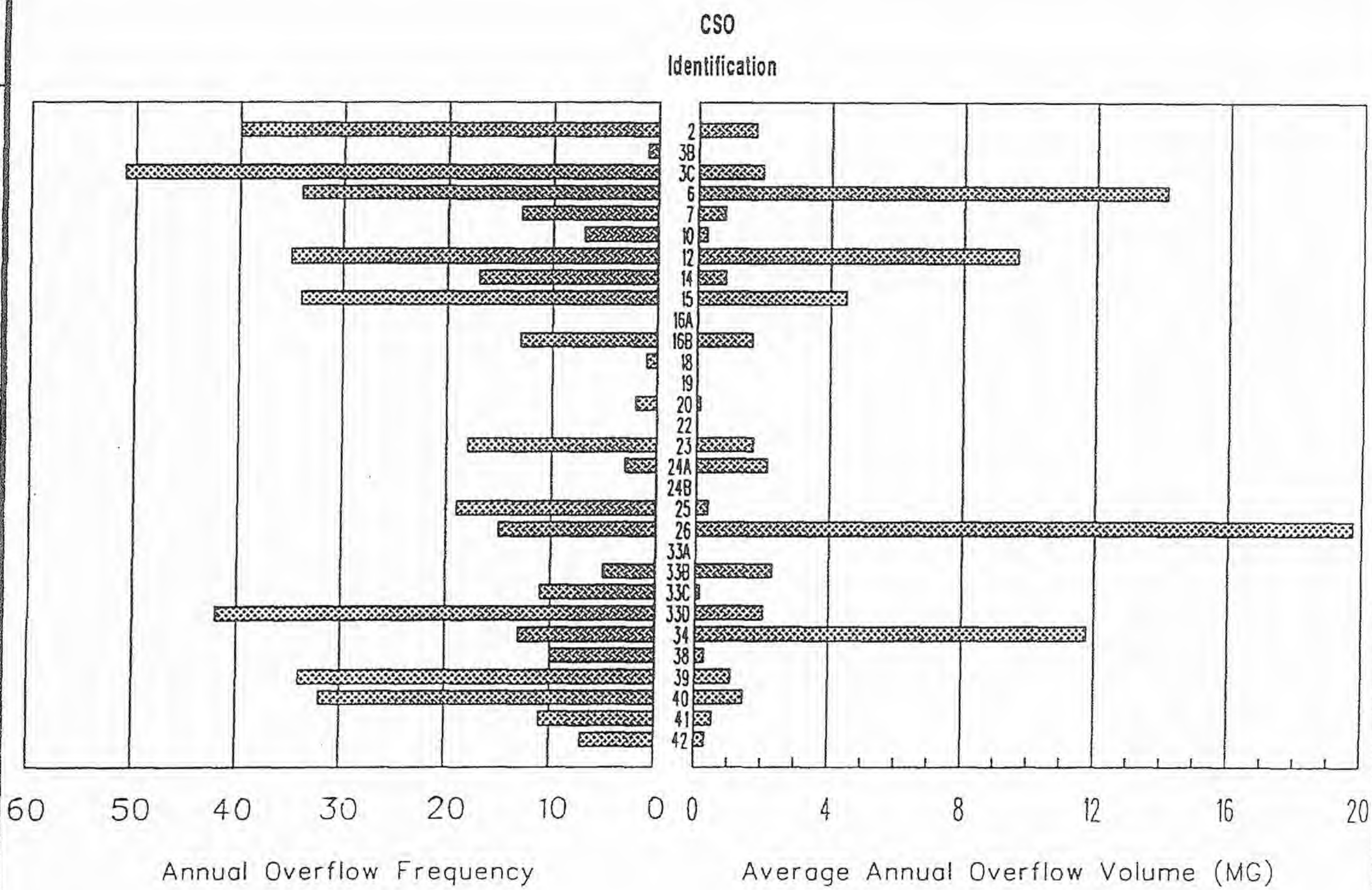
FIGURE 3-9

ANNUAL OVERFLOW QUANTITIES



3.4 CSO EVALUATION GROUPS

As an aid to model analysis the combined sewer overflow basins were categorized into 12 groups. Analyzing CSO basins by group facilitated the use of hydrologic and topographic information and its subsequent conversion into model calibration parameters. The criteria for defining an evaluation group were complex but generally objective. These groups were consistent throughout the project work. The following is a list of all CSOs and their grouping. Figure 3-6 provides further clarification of the relationships between CSOs.

CSO Group #	CSOs in Group	Group Characteristics
1	2, 3B, 3C	geographic, some hydraulic
2	6, 7	geographic
3	10, 12	geographic
4	14, 15	hydraulic
5	16A, 16B, 18	geographic
6	19	isolated
7	20, 24, 24A, 24B, 26	hydraulic
8	22, 25	hydraulic
9	23	isolated
10	33A, 33B, 33C, 33D	geographic, some hydraulic
11	34	isolated
12	38, 39, 40, 41, 42	geographic

CSOs that are in series above the interceptor, such that a downstream CSO re-regulates flow that has passed an upstream CSO, were regarded as a CSO group for modeling and evaluation. Examples of this type of grouping are the CSOs 14 and 15 in the southern west central neighborhood; 22 and 25 in Peaceful Valley; and 20, 24, and 26 on the western South Hill and the Central Business District. These groups do not necessarily have internally homogenous land use or topography, but the hydraulic connection is important enough to treat them as a group.

Geographic proximity also determined groups of CSO regulators (see Figure 3-3). These groups are not directly connected hydraulically, but the basins regulated by the CSOs are adjacent to one another, are hydrologically similar and have similar land use patterns. Such groups included CSOs 6 and 7 in the Shadle Park area and north of Downriver Golf Course; 10 and 12 in the northern West Central neighborhood; and 16A, 16B, and 18 draining the basins above the mouth of and west of Latah Creek. The group including 38, 39, 40, 41, and 42 along the upstream reach of the Spokane River in east Spokane fits most criteria for this determination, except basins 41 and 42 are not contiguous with

38, 39, and 40; however, these five basins are the furthest up the I05 interceptor. The disparity in basin size within a given group did not affect evaluation.

Two groups are defined by being hydraulically connected as well as the regulators being in close geographic proximity. One such group includes 2, 3B, and 3C near Joe Albi Stadium. On the Indian Trail interceptor, intercepted flow from CSO structure 2 flows into CSO structure 3C and the basin of CSO 3B is adjacent to the basin of CSO 3C. The group including 33A, 33B, 33C, and 33D, draining the central South Hill down to Sprague Avenue, are close geographically and share a common outfall. Intercepted flow from CSO structure 33A flows into CSO structure 33B.

There are three CSO regulators draining individual evaluation areas. These are CSO basins 19, draining the western edge of the South Hill; 23, the area west of Monroe around the Spokane County Courthouse; and 34, which is the eastern South Hill. CSO 19 is 5,200 feet upstream of the Clarke Avenue pump station, isolated from other CSO basins and from the interceptor system. CSO 19 is a side weir structure; for the 10-year STORM simulation, CSO 19 did not overflow once (See Chapter 4 and Appendix E for discussions of STORM). The structure at CSO 23 regulates a basin that is 57 percent commercial. This differentiates it from the adjacent CSO basins 14 and 15. CSO regulator 34 serves a very large basin without upstream regulating structures, so that it is justifiable to analyze it alone.

3.5 TRIBUTARY LAND USES

The combined sewer areas of the City of Spokane generally have medium density residential land use, with some notable exceptions. Some of the smaller CSO basins are homogenous and tend to be older residential areas. The approximate land use acreages from the Sewer Network Analysis Program (SNAP) model database are shown in Table 3-3 and in Appendix F.

Approximately 75 percent of the combined sewered area is zoned medium density residential. The CSO basins for which the majority land use is not medium density residential are 3B, 16A, 19, 23, 25, 26, 33C, and 33D. Additional areas that have separate storm sewers also contribute sanitary flows through certain CSO structures. Areas with some tributary separated areas include the basins regulated by CSOs 6, 7, and 20. These areas were accounted for during analysis with the STORM and SWMM models.

TABLE 3-3. CSO BASIN LAND USE*

CSOs	Total Acres	Residential Low	Residential Medium	Residential High	Commercial	Industrial
02	84	0	84	0	0	0
03B	10	0	0	0	10	0
03C	17	0	17	0	0	0
06	619	0	590	0	29	0
07	190	0	190	0	0	0
10	75	0	52	0	23	0
12	345	0	242	13	56	34
14	79	0	79	0	0	0
15	129	19	110	0	0	0
16A	56	0	7	0	49	0
16B	75	0	75	0	0	0
18	11	0	11	0	0	0
19	41	0	22	19	0	0
20	407	0	407	0	0	0
22	38	0	38	0	0	0
23	168	0	86	0	82	0
24A	1,385	0	1,364	0	21	0
24B	20	0	20	0	0	0
25	24	0	6	7	11	0
26	940	0	0	324	563	0
33A	53	0	53	0	0	0
33B	1,256	0	1,236	7	13	0
33C	14	0	0	0	14	0
33D	45	0	0	0	45	0
34	1,409	0	1,119	17	132	141
38	73	0	73	0	0	0
39	51	0	51	0	0	0
40	56	0	56	0	0	0
41	87	0	87	0	0	0
42	82	0	55	0	0	27

* Some total acreages include other flow generating areas, such as hospitals.

3.6 CITY DRAINAGE POLICY EFFECTS ON CSOs

The City of Spokane currently has a two-tiered policy related to drainage. The first tier is the City's New Development drainage ordinance, the text of which is in Appendix G.

The second tier is the Spokane County's *Guidelines for Storm Water Management* produced in a cooperative effort between the City and Spokane County (Spokane County, 1984). This policy affects CSOs by limiting the amount of runoff that reaches the combined sewer from new construction.

Another consideration in storm water disposal is the effect of storm water infiltration on groundwater quality. From 1977 through 1978 Spokane County conducted a study of human activity above the Spokane-Rathdrum Aquifer to determine if groundwater quality was being altered as it flows through the area, and if so, the extent and causes of alteration. It was determined that one of the potential sources of pollution was surface water runoff, especially if disposed of by dry wells. The City and Spokane County now both require grass swales for storm water disposal. The expected contaminant removal rates for a properly maintained swale are as follows (Spokane County Engineer's Office, 1984).

Contaminant	Removal-Percent
Total suspended solids	95
Total dissolved solids	50
Nutrients	
Nitrate	20-50
Total Nitrogen	80
Phosphorus	90
Metals	>80
Organic Chemicals	>60
Bacteria	99

The net effect of the City's drainage policy is that no new storm water connections from new development or redevelopment are to be made to the combined sewer system. As a result, newer commercial developments on the South Hill have a very low runoff rates to combined sewers compared to older developments in the combined sewer areas. Control of on-site storm water with new development and redevelopment involves various methods for drainage control.

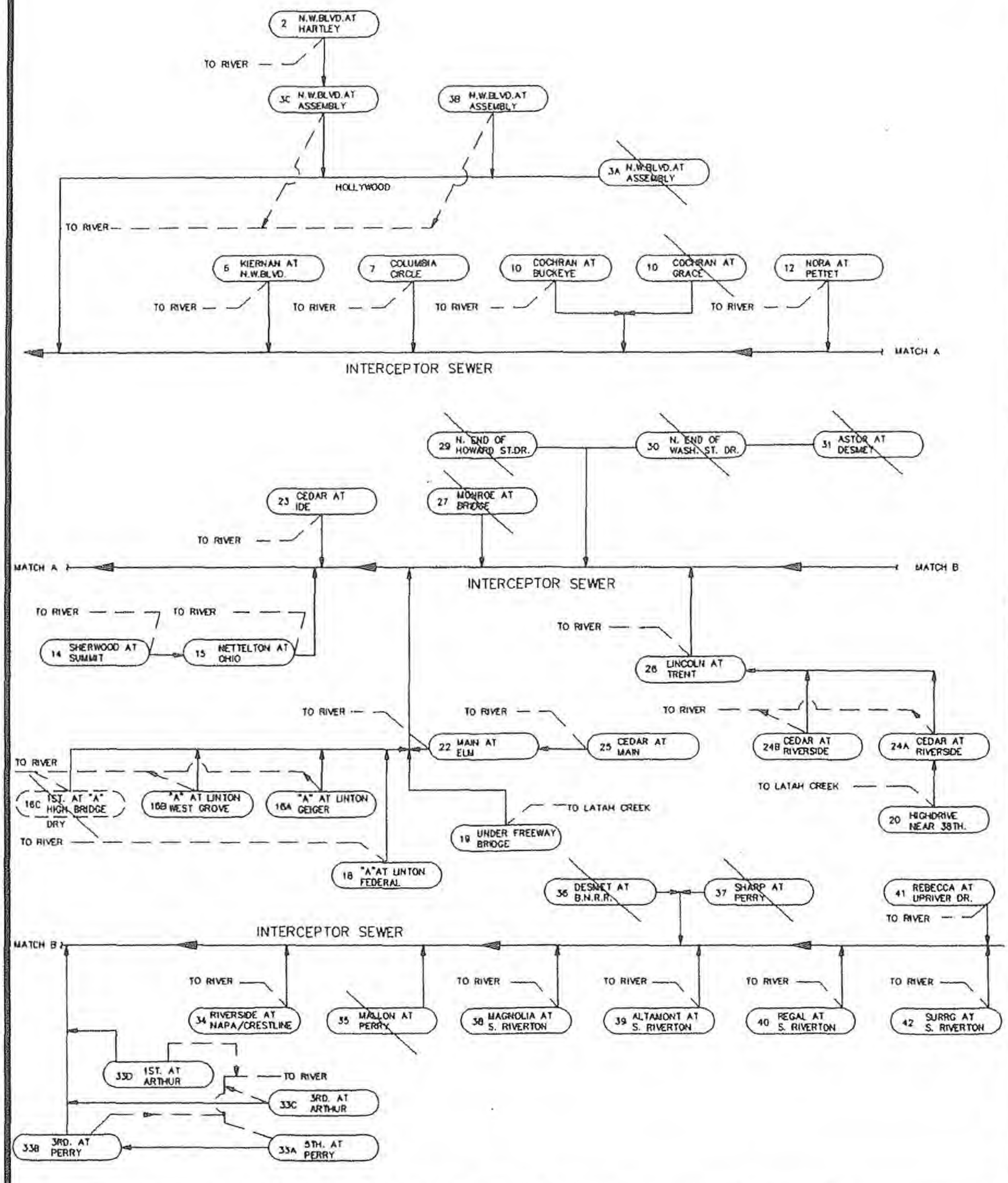


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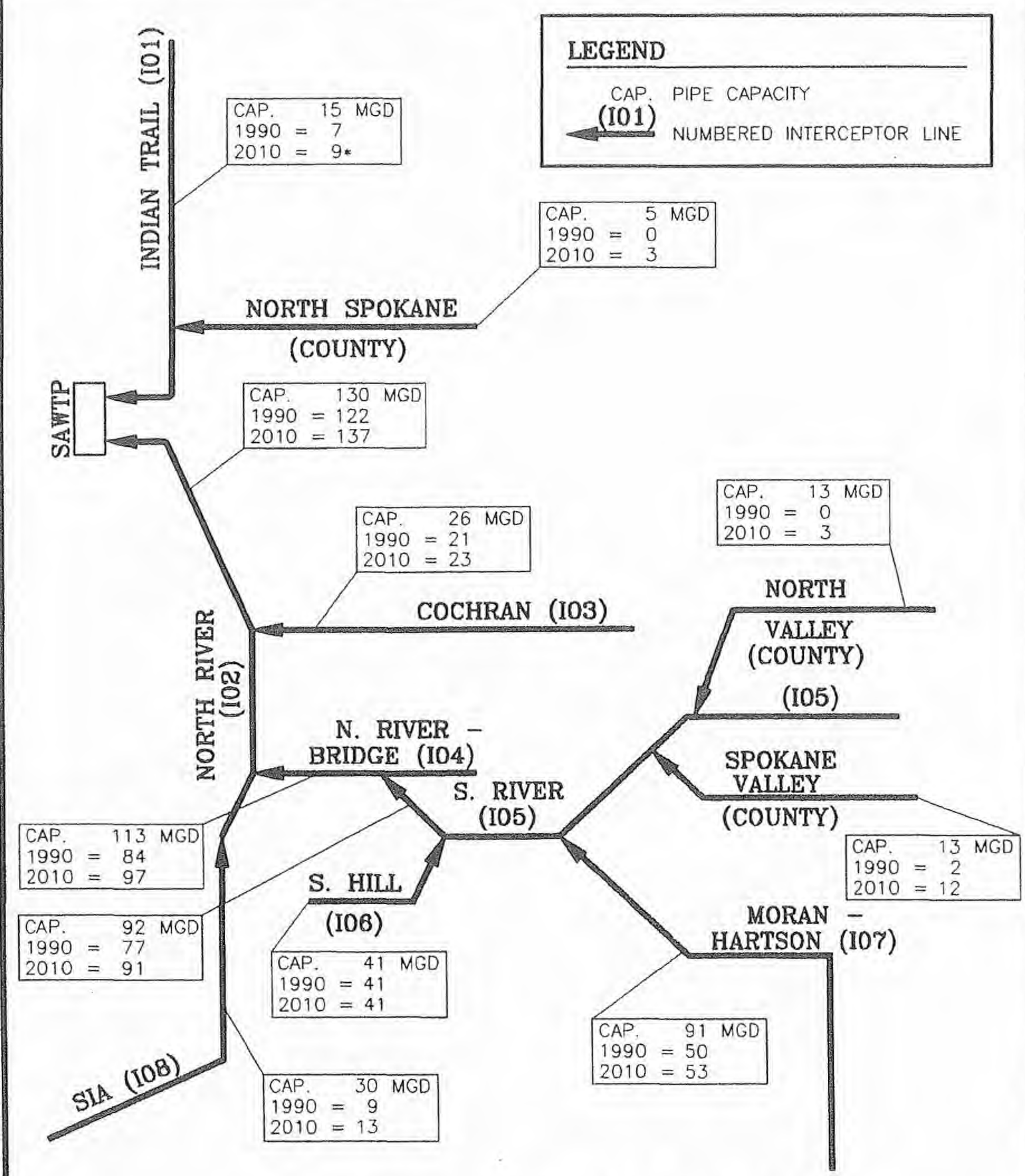
FIGURE 3-6

COMBINED SEWER OVERFLOW SCHEMATIC RELATION TO INTERCEPTOR SEWER



* THIS FIGURE IS LOWER THAN THE DRY WEATHER FLOW DUE TO A HIGH DRY WEATHER PEAKING FACTOR.

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CITY OF SPOKANE WASHINGTON FOUNDED IN 1881

CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN

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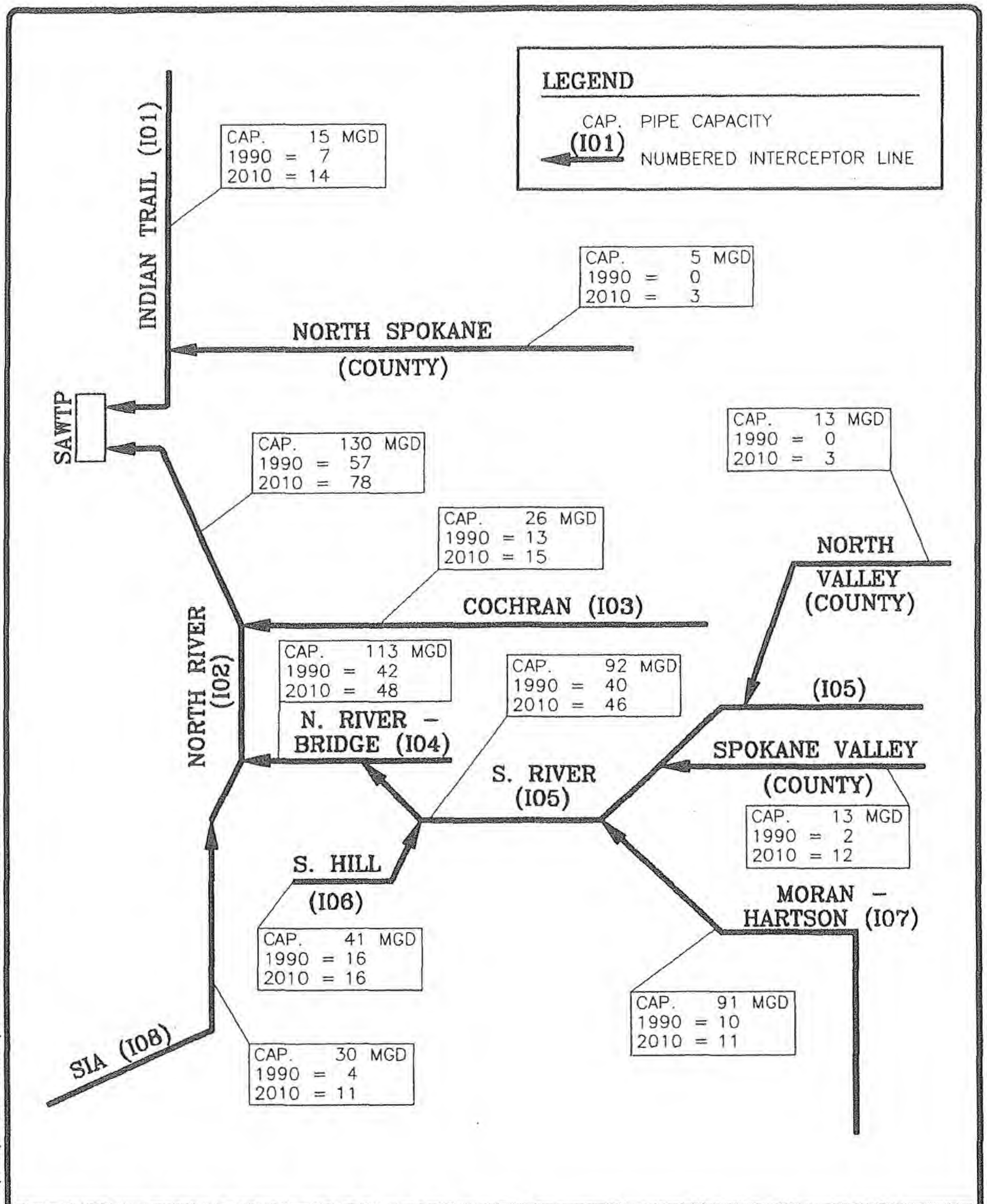
FIGURE 3-7

INTERCEPTOR SCHEMATIC PEAK 5-YEAR WET WEATHER FLOWS WITHOUT CSO REDUCTION



CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN

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FIGURE 3-8

INTERCEPTOR SCHEMATIC
PEAK DRY WEATHER FLOWS

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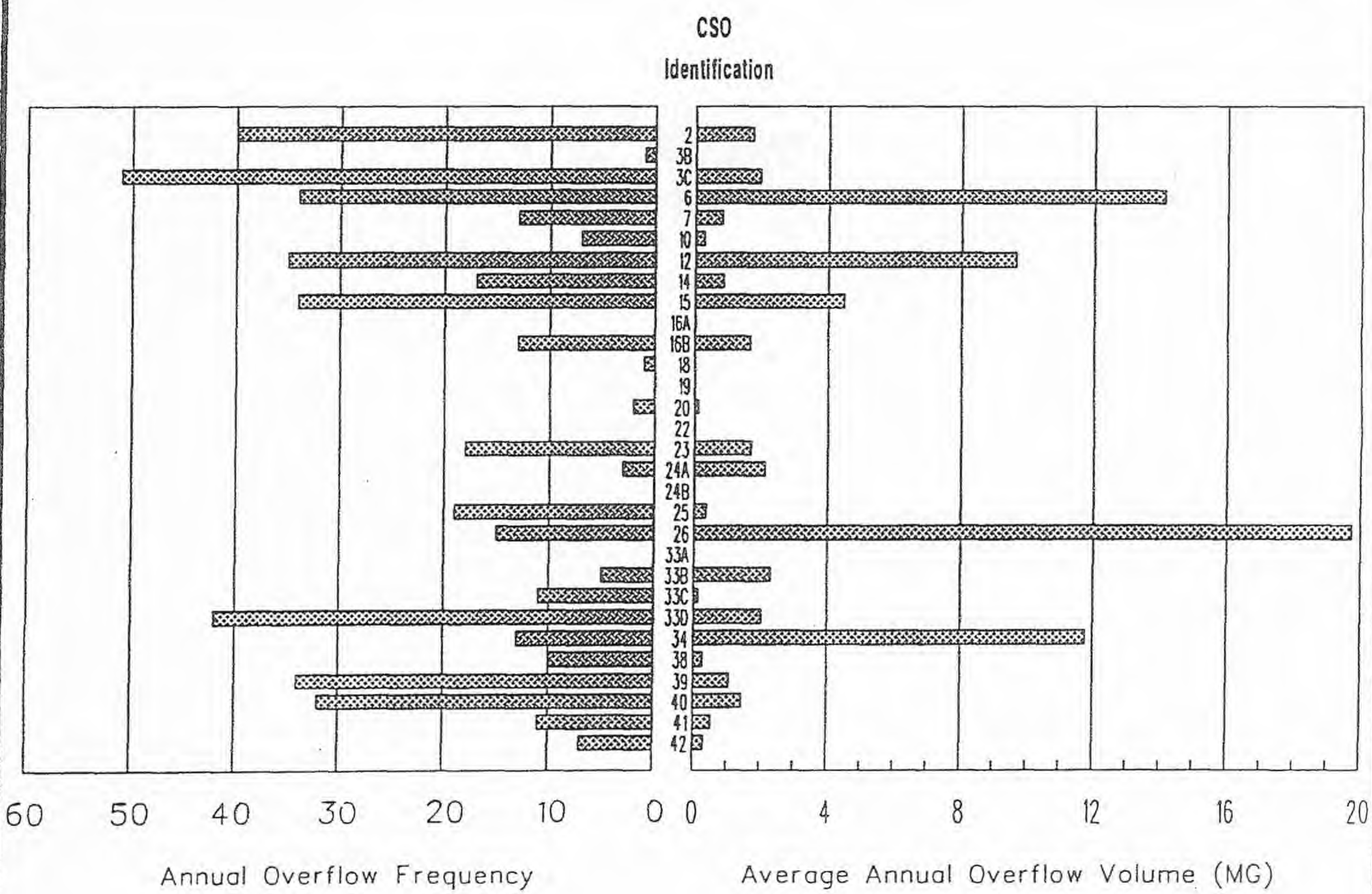

CITY OF SPOKANE
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FIGURE 3-9

ANNUAL OVERFLOW QUANTITIES

4

4

BOVAY
NORTHWEST

CHAPTER 4. CHARACTERIZATION OF COMBINED SEWER OVERFLOWS

In this Chapter combined sewer overflows in the City of Spokane are defined and the strategy for reduction of CSOs is introduced. Following the CSO characterization is supporting information, including results from modeling flows in the existing system and pertinent water quality data.

4.1 CSO REDUCTION CHARACTERIZATION AND GOALS

Combined sewer overflows impact Spokane River water quality. The data presented in Section 4.2 on annual CSO volume and frequency and in Section 4.3 on select water quality parameters provide the background for characterizing CSOs for the City of Spokane. Spokane's CSOs annual average discharge to the Spokane River and its tributary system is approximately 78 MG. The average CSO concentration of total phosphorus is over 2 milligrams per liter (mg/l). The average fecal coliform count in CSO is approximately 2,000,000 organisms per 100 milliliter (ml), compared to 20,000 organisms per 100 ml in storm drainage. CSO fecal coliforms are at a high enough concentration in CSO to contribute to the fecal coliform counts above ambient levels. The Spokane River had peaks of over 700 organisms/100ml observed in the *1990 Spokane River Study* during storm events.

Because of the potential affects of CSOs on water quality, WAC 173-245 requires that municipalities prepare plans to achieve the "greatest reasonable reduction of combined sewer overflows at the earliest possible date." This is to be accomplished considering the "economic capability of the municipality." The goal of the City is to establish an economically viable reduction program utilizing the data gathered for and presented in this Plan. WAC 173-245-040, Section (2)(e) states "Factors which municipalities and the department shall use to determine compliance schedules shall include but not be limited to:

- (i) Total cost of compliance (including past expenditures)
- (ii) Economic capability of the municipality
- (iii) Other recent and concurrent expenditures for improving water quality; and
- (iv) The severity of existing and potential environmental and beneficial use impacts."

This section means reducing overflow to a one event per year frequency over time as the City is financially able will meet with Ecology approval. Therefore the City will work toward the goal of one overflow per year per CSO outfall as required by WAC 173-245.

The City is using the assumption that the one event per year criteria at the outfall can be met by restricting overflow at each regulator upstream of the outfall to one event per year. This is a reasonable assumption because on the average, overflow at a given CSO regulator, resulting from a one year storm (as conservatively defined in this chapter) will be the threshold cause of overflow at regulators in adjacent basins that share the same outfall. This assumption is predicated on regulators being previously adjusted to the one overflow per year setting.

4.2 CSO QUANTITY

Annual combined sewer overflow volumes for each CSO regulator were determined with the calibrated hydrologic model. These volumes are presented in Table 4-1.

CSO volume and frequency determinations were made with simulations considering snowmelt and not considering snowmelt, as indicated in Table 4-1. The greatest annual volume of overflow occurs at CSO regulator 26, draining an existing area of over 3,000 acres, of which 2,752 acres contribute storm flows to the combined system. By 2010, it is projected that an additional 131 acres of low-to-medium density residential homes on the South Hill will drain to CSO regulator 26. This basin includes the central business district as well as residential neighborhoods.

There are three CSO regulators in addition to CSO 26 that overflow near or over 10 MG per year. These regulators are CSOs 6, 12, and 34, which are highlighted in Figure 4-1. Land uses in these basins are predominantly residential, with some significant commercial area as well. CSO 6 is located at Northwest Boulevard at the extension of Kiernan Avenue, and its drainage includes the Shadle Park shopping center, Shadle Park High School, and Grover Middle School. The area drained by CSO 12 includes the commercial strip along Monroe Street south of the intersection of Monroe, Northwest Boulevard, and Indiana Avenue to Monroe and Boone Avenue. There are two large areas of commercial activity drained by the basin of CSO regulator 34, including the strip along east Sprague Avenue from Havana to Napa and the Lincoln Heights area. Over half of the area drained by CSO 34 is now separated. Modeling CSO volume and frequency is discussed in Section 4.4.

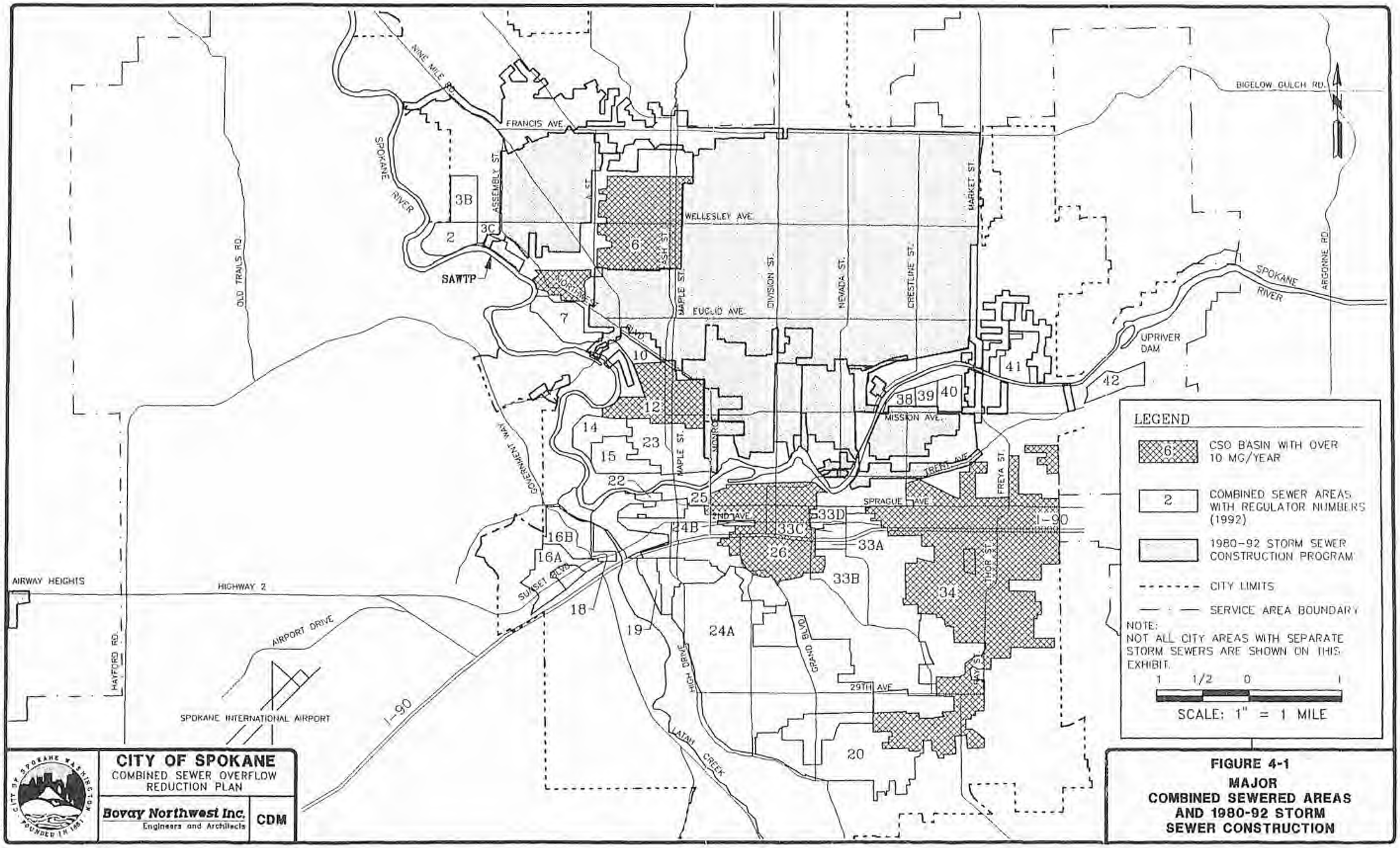

FIGURE 4-1
MAJOR COMBINED SEWERED AREAS AND 1980-92 STORM SEWER CONSTRUCTION

TABLE 4-1. AVERAGE ANNUAL CSO VOLUMES AND FREQUENCIES

CSO No.	CSO Location	Annual Overflow Volume[1, 2] (MG)[4] With Snow Melt	Annual Overflow Volume[1, 2] (MG)[4] Without Snow Melt	Frequency of Overflows[3] (annual) With Snow Melt	Frequency of Overflows[3] (annual) Without Snow Melt
2	NW Blvd. at Hartley	1.72	1.48	40	40
3B	NW Blvd. at Assembly (from Albi)	0.00	0.00	1	2[5]
3C	NW Blvd. at Assembly (from Royal)	1.94	1.67	51	55[5]
6	Kiernan at NW Blvd.	14.12	10.08	34	33
7	Columbia Circle	0.81	0.72	13	12
10	Cochran at Buckeye	0.27	0.22	7	6
12	Nora at Pettet	9.65	7.40	35	33
14	Sherwood at Summit	0.86	0.71	17	15
15	Nettleton at Ohio	4.47	3.92	34	34
16A	"A" Street at Linton	0.01	0.00	0	0
16B	"A" Street at Linton	0.50	0.47	12	11
18	1st at "A" Street	0.00	0.00	1	1
19	Under Freeway Bridge	0.00	0.00	0	0
20	High Drive near 33rd	0.55	0.44	3	3
22	Main at Oak St.	0.00	0.00	0	0
23	Cedar at Ide	1.69	1.51	18	17
24A	Cedar at Riverside	2.12	1.92	3	3
24B	Cedar at Riverside	N/A	N/A	N/A	N/A
25	Cedar at Main	0.35	0.33	19	18
26	Lincoln at Spokane Falls	19.73	16.44	15	14
33A	5th at Arthur	0.00	0.00	0	0
33B	3rd at Perry	2.30	2.05	5	5
33C	3rd at Arthur	0.12	0.11	11	10
33D	1st at Arthur	2.03	1.78	42	42
34	Riverside at Napa/Crestline	11.78	9.95	13	13
38	Magnolia at S. Riverton	0.28	0.22	10	9
39	Altamont at S. Riverton	1.06	0.89	34	34
40	Regal at S. Riverton	1.45	1.25	32	31

TABLE 4-1. AVERAGE ANNUAL CSO VOLUMES & FREQUENCIES (cont.)

CSO No.	CSO Location	Annual Overflow Volume[1, 2] (MG)[4] With Snow Melt	Annual Overflow Volume[1, 2] (MG)[4] Without Snow Melt	Frequency of Overflows[3] (annual) With Snow Melt	Frequency of Overflows[3] (annual) Without Snow Melt
41	Rebecca at Upriver Dr.	0.52	0.47	11	10
42	Surro at S. Riverton	0.31	0.29	7	6
TOTAL		78.64	64.31		

1. STORM simulation includes effects of snowmelt.
2. Values rounded to nearest 10,000 gallons.
3. A "0" indicates less than one event in 2 years.
4. MG = million gallons.
5. High overflow frequencies without snowmelt are due to combining runoff events during period of low temperature.

4.3 POLLUTANT LOADS

Pollutant loads were simulated using volumetric data produced from the STORM model. Water quality parameter data collected from samplers installed at selected CSO regulators was analyzed for variability. The analysis indicated there is not a statistically significant correlation between land use and contaminant load in CSO effluent. The pollutant load was therefore assumed to be uniform and a statistical mean load was assigned to each CSO based on annual volumes and 1-year storm event volumes estimated with the STORM. Water quality data from CSOs and the Spokane River was collected for the *1990 Spokane River Study*. Data on CSO water quality from this effort is shown in Table 4-2, and dry weather and wet weather Spokane River water quality data is shown in Table 4-3.

4.3.1 Nutrient Loads and River Water Quality

Existing Spokane River water quality is designated Class "A" by Ecology. Total phosphorus loading to Long Lake is limited to 536 pounds per day. Dissolved oxygen in the Spokane River must exceed 8.0 mg/l at all times to comply with Class "A" standards. To comply with Class "A" standards, fecal coliform is limited to an average value of 100 organisms per 100 ml sample, with no more than 10 percent of samples exceeding 200 organisms per 100 ml sample.

The requirements ofWAC 173-245-040 exempt most of the CSO sites which have not been monitored to the date of this Plan from sampling, since only five CSOs drain areas that are not predominantly residential. These CSOs are Nos. 23, 25, 26, 33C, and 33D. The CSOs at 23 and 26 have automatic wastewater samplers, and grab samples during an overflow event have been taken from CSOs 25, 33C, and 33D.

The data in Table 4-2 indicates that the Spokane River may be significantly impacted by total kjeldahl nitrogen (TKN) and total suspended solids (TSS) loads from CSOs. Impact to the Spokane River from CSO TKN and TSS loads were also indicated in the *1990 Spokane River Study* (Soltero et al, 1990). Dissolved oxygen (DO) levels were at or above the Class "A" river standard of 8.0 mg/l on all dates at all Spokane River sampling points below Spokane Falls, indicating that biological oxygen demand (BOD) introduced from CSOs is not high enough to depress DO below the standard. However, total phosphorus (TP) loadings to the river may increase the nutrient level in Long Lake.

Analysis of data compiled from CSOs since 1989 indicates that the average daily TP discharge is 45 pounds per event with a maximum of 220 pounds. The maximum discharge occurred on June 6, 1990. Total phosphorus loading will be considered in evaluating CSO control/treatment alternatives.

TABLE 4-2. CSO WATER QUALITY

AVERAGE INPUT TO SPOKANE RIVER FROM CSO DURING STORMS OF 0.15 INCHES OR GREATER							
	Parameter Concentrations				Average Load to River		
Location	TKN[1] (mg/l)[4]	TP[2] (mg/l)	TSS[3] (mg/l)	Flow (cfs)[5]	TKN (lbs)[6]	TP (lbs)	TSS (lbs)
Measured							
CSO 12	10.0	2.3	251	1.545	20.10	4.65	505.28
CSO 15	2.8	3.5	266	0.084	2.61	3.30	247.95
CSO 26	8.5	1.2	211	3.218	35.13	9.21	866.43
CSO 34	9.9	3.6	435	0.945	24.37	8.85	1069.67
Estimated - Calculated Flow Weighted Average							
CSO 2	7.8	2.9	291	0.046	2.79	1.05	104.00
CSO 3B	7.8	2.9	291	0.004	0.01	0.003	0.30
CSO 3C	7.8	2.9	291	0.041	3.15	1.18	117.39
CSO 6	7.8	2.9	291	0.447	23.00	8.60	856.02
CSO 7	7.8	2.9	291	0.069	1.32	0.50	49.27
CSO 10	7.8	2.9	291	0.040	0.45	0.17	16.67
CSO 14	7.8	2.9	291	0.056	1.71	0.16	23.03
CSO 16A	7.8	2.9	291	0.022	0.02	0.001	0.20
CSO 16B	7.8	2.9	291	0.134	3.33	0.32	44.74
CSO 18	7.8	2.9	291	0.003	0.01	0.001	0.08
CSO 19	7.8	2.9	291	*	Overflows less than 1/year		
CSO 20	7.8	2.9	291	0.060	0.22	0.02	2.97
CSO 22	7.8	2.9	291	0.022	0.01	<0.001	0.07
CSO 23	7.8	2.9	291	0.100	3.37	0.32	45.31
CSO 24	7.8	2.9	291	0.736	4.22	0.40	56.83
CSO 25	7.8	2.9	291	0.020	0.70	0.07	9.45

TABLE 4-2. CSO WATER QUALITY (cont.)

AVERAGE INPUT TO SPOKANE RIVER FROM CSO DURING STORMS OF 0.15 INCHES OR GREATER							
Parameter Concentrations					Average Load to River		
Location	TKN[1] (mg/l)[4]	TP[2] (mg/l)	TSS[3] (mg/l)	Flow (cfs)[5]	TKN (lbs)[6]	TP (lbs)	TSS (lbs)
CSO 33A	7.8	2.9	291	*	Overflows less than 1/year		
CSO 33B	7.8	2.9	291	0.484	4.59	0.44	61.80
CSO 33C	7.8	2.9	291	0.012	0.24	0.02	3.19
CSO 33D	7.8	2.9	291	0.052	4.04	0.38	54.37
CSO 38	7.8	2.9	291	0.029	0.55	0.05	7.45
CSO 39	7.8	2.9	291	0.034	2.12	0.20	28.53
CSO 40	7.8	2.9	291	0.049	2.89	0.27	38.88
CSO 41	7.8	2.9	291	0.050	1.04	0.10	13.95
CSO 42	7.8	2.9	291	0.048	0.61	0.06	8.22
TOTALS					137	46.6	4734

1. TKN = total kjeldahl nitrogen.
2. TP = total phosphorus.
3. TSS = total suspended solids.
4. mg/l = milligrams per liter.
5. cfs = cubic feet per second.
5. lbs = pounds.

TABLE 4-3. SPOKANE RIVER WATER QUALITY

	Average Wet Weather River Values Parameter Concentrations				Average Ambient (Dry Weather) River Values Parameter Concentrations		
LOCATION	TKN[1] (mg/l)[2]	TP[3] (ug/l)[4]	TSS[5] (mg/l)	FLOW (cfs)[6]	TKN (mg/l)	TP (ug/l)	TSS (mg/l)
Waterworks	0.29	17	1.5	5978	0.17	13	1.5
CSOs 41, 42							
Greene Street Bridge	0.31	15	2	5978	0.19	12	1.5
CSOs 38, 39, 40							
Mission Street Bridge	0.33	17	1.5	5978	0.19	16	1.5
Trent Avenue Bridge	0.29	15	1.5	5978	0.21	14	1.5
CSOs 33, 34							
Division Street Bridge	0.31	21	1.5	5979.6	0.17	18	1.5
CSOs 23, 24, 25, 26							
Maple Street Bridge	0.38	20	2	5982	0.16	16	1.5
CSOs 16, 18, 22							
Above CSO 15 Outfall	0.52	24	2	5982	--	--	--
CSOs 19, 20							
Latah Creek Mouth	1.23	148	25	45.75	0.84	173	245
CSO 14, 15							
Above CSO 12 Outfall	0.47	22	3	6027.75	--	--	--
CSO 12							
Fort Wright Bridge	0.81	24	2	6029.75	0.34	47	48
CSOs 7, 10							
Old Children's Home	0.9	19	3	6040	--	--	--
SAWTP CSOs 2, 3, 6							
Bowl & Pitcher	1.02	67	2	6100	0.3	54	39
Seven Mile Bridge	0.7	63	2	6100	0.28	61	29

1. TKN = total kjeldahl nitrogen.
2. mg/l = milligrams per liter.
3. TP = total phosphorus.
4. ug/l = micrograms per liter.
5. TSS = total suspended solids.
6. cfs = cubic feet per second.

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Analysis of fecal coliform indicated that during wet weather the concentration of fecal coliform increases by 750 organisms per 100 ml from upstream of the City near Upriver Dam to the mouth of Latah Creek (see Figure 4-1). The average wet weather concentration in Latah Creek for the four samples taken during the *1990 Spokane River Study* was 2,600 organisms per 100 ml of fecal coliform, resulting in a total increase of 1,500 organisms per 100 ml before reaching the wastewater treatment plant. Fecal coliform levels upstream of the City were 32 organisms per 100 ml, within the Draft WAC 173-203 standard.

The coliform count increases immediately downstream of the CSO outfalls along South Riverton below the Green Street Bridge (38, 39, and 40); at the Division Bridge, downstream of CSO outfalls for regulator 34 and the four regulators for 33; and below the Maple Bridge downstream of the discharges for CSOs 23, 24, 25, and 26. The average fecal coliform concentration in these CSOs was 2,000,000 organisms per 100 ml for the four samples, and for storm drains the fecal coliform count was 20,000 organisms per 100 ml. Even though storm water discharges average an estimated 700 MG to the Spokane River annually, about 9 times the volume discharged from CSOs, CSOs have about 100 times the concentration of fecal coliform.

4.3.2 Bottom Sediment Quality

During the 1990 Spokane River Study conducted by Soltero and Eastern Washington University, 21 outfalls were found in a survey of the 24 listed in the NPDES permit. Outfalls 38, 39, and 40 were not found after an extensive search. Sediment samples were taken at 7 of the 21 outfalls inspected. Those outfalls were 2, 3, 6, 7, 23, 34, and 42. Other outfalls did not have detectable sediment depositions in their vicinity. The sample location of the sediment in relation to the outfall and other field notes were given in Appendix B of the *1990 Spokane River Study Report* (Soltero et al, 1990). The sampled deposits were primarily silts and gravels normally found in the river and no sludge deposits were observed at any site. An exception was some solidified tar evident in the pipe or in close proximity at CSO outfalls 6, 22, and 25 (Soltero et al, 1990).

On October 22, 1989, samples were taken just downstream of the municipal waterworks building and at Seven Mile bridge for priority pollutant scans; each priority pollutant scan analysis included 13 metals, cyanide, total phenol, and volatile, semi-volatile and pesticide/PCB organic fractions. The analyses detected no volatiles, polychlorobiphenyls, or pesticides at either site. Metal contamination was evident at both sites with arsenic and copper being found at the upstream site, zinc was found at both sites, and lead was found at the downstream site. The majority of the metals are probably due to historic mining operations near Kellogg, Idaho (Bovay Northwest, 1991A). In conclusion, CSO does not demonstrably affect bottom sediment quality in the Spokane River.

4.4 COMPUTER MODELS

The purpose of mathematical modeling is first to simulate existing conditions in order to estimate annual CSO frequency and volume, and then to simulate possible physical changes to the wastewater system. The resulting information is used to evaluate the control/treatment alternatives in order to achieve the greatest reasonable reduction at each CSO site. Two basic types of data are used in the models. Hydrologic data is derived from precipitation records and flow monitoring data. Sewer system data is used to simulate hydraulic elements in the City of Spokane's combined sewer system. Figure 4-2 illustrates the Model Areas served by the sewer system.

Three computer models are used in developing data used in this Plan. The first two models create a data set that is used in the third model which describes the hydraulic behavior of CSOs under existing conditions and then with different control/treatment alternatives. The models fit into a process described in Figure 4-3, which illustrates the process of calibrating the models and the alternative evaluation. The models are briefly highlighted in the following subsections.

4.4.1 Sewer Network Analysis Program

The SNAP is a model by Camp, Dresser & McKee, Inc. The SNAP is used in this study to simulate existing and future peak steady state flows in the wastewater collection system, identifying improvements to correct pipe capacity deficits. The model has been modified to incorporate information from the CSO and interceptor monitoring program conducted during 1991 and subsequent field investigations by the City and Bovay. City personnel checked the database for accuracy and consistency in areas of apparent hydraulic irregularity. Appendix F includes detailed information on the SNAP.

4.4.2 Storage, Treatment, Overflow Runoff Model

The Hydrologic Engineering Center, U.S. Corps of Engineers' STORM is a model developed specifically to simulate combined sewer overflows for extended periods (i.e. months or years). It uses precipitation records and observed overflow rates to simulate hydrologic conditions and calculate the frequency and volume of overflows. The model simulates a single basin at a time, and does not route flows through pipes. To correctly simulate overflow frequencies and volumes it incorporates basin characteristics by accounting for total acreage, land use, soil type, travel time, and attenuation of peak flow rates. The STORM was useful for CSO analyses because it simulates the effects to the frequency and volume of overflows caused by modifying regulator settings or providing storage of wet weather flows. The STORM was calibrated using flow data from monitors and monitoring by ADS Environmental Services, Inc. Additional information about the STORM can be found in Appendix E.

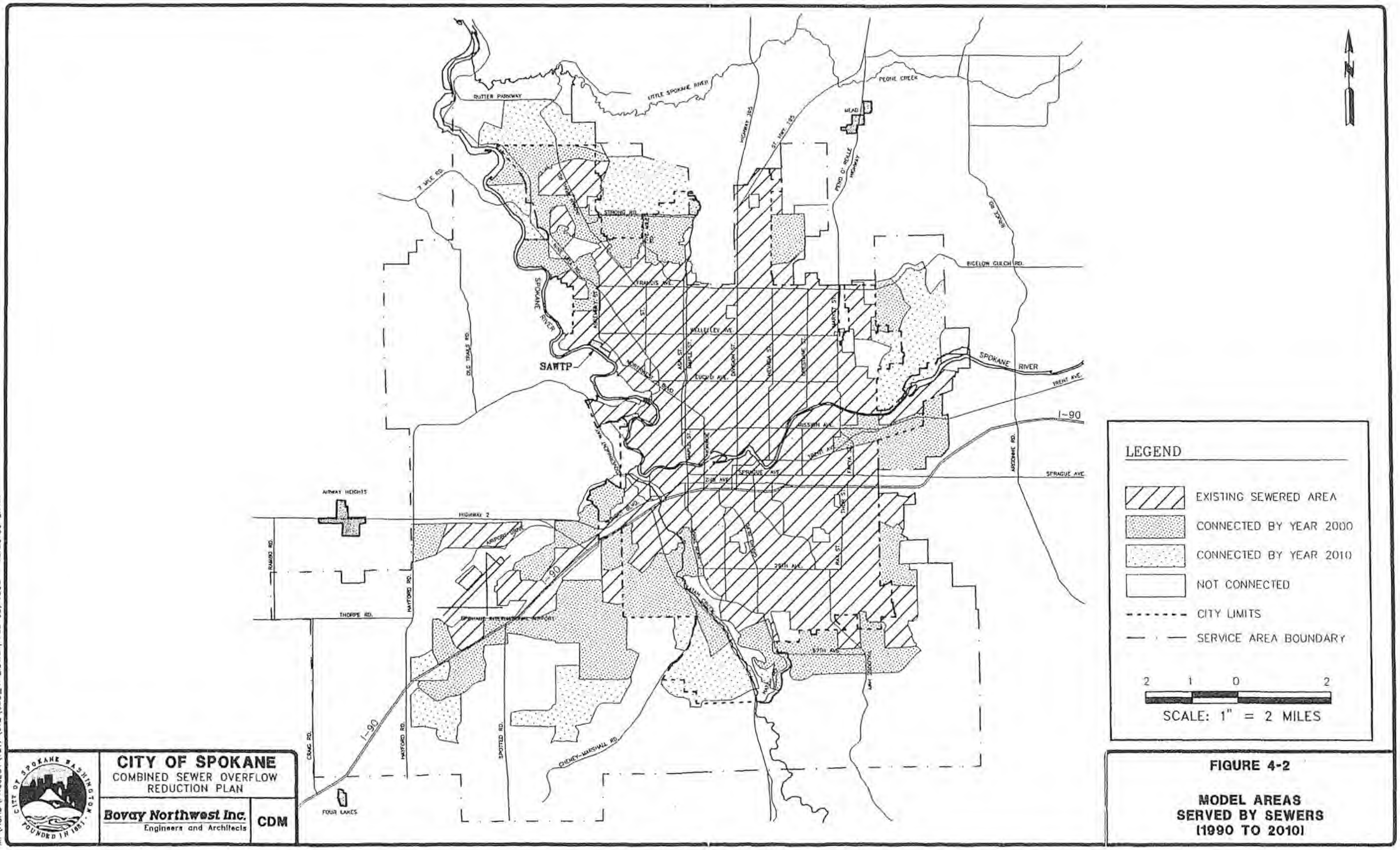

FIGURE 4-2

MODEL AREAS SERVED BY SEWERS (1990 TO 2010)

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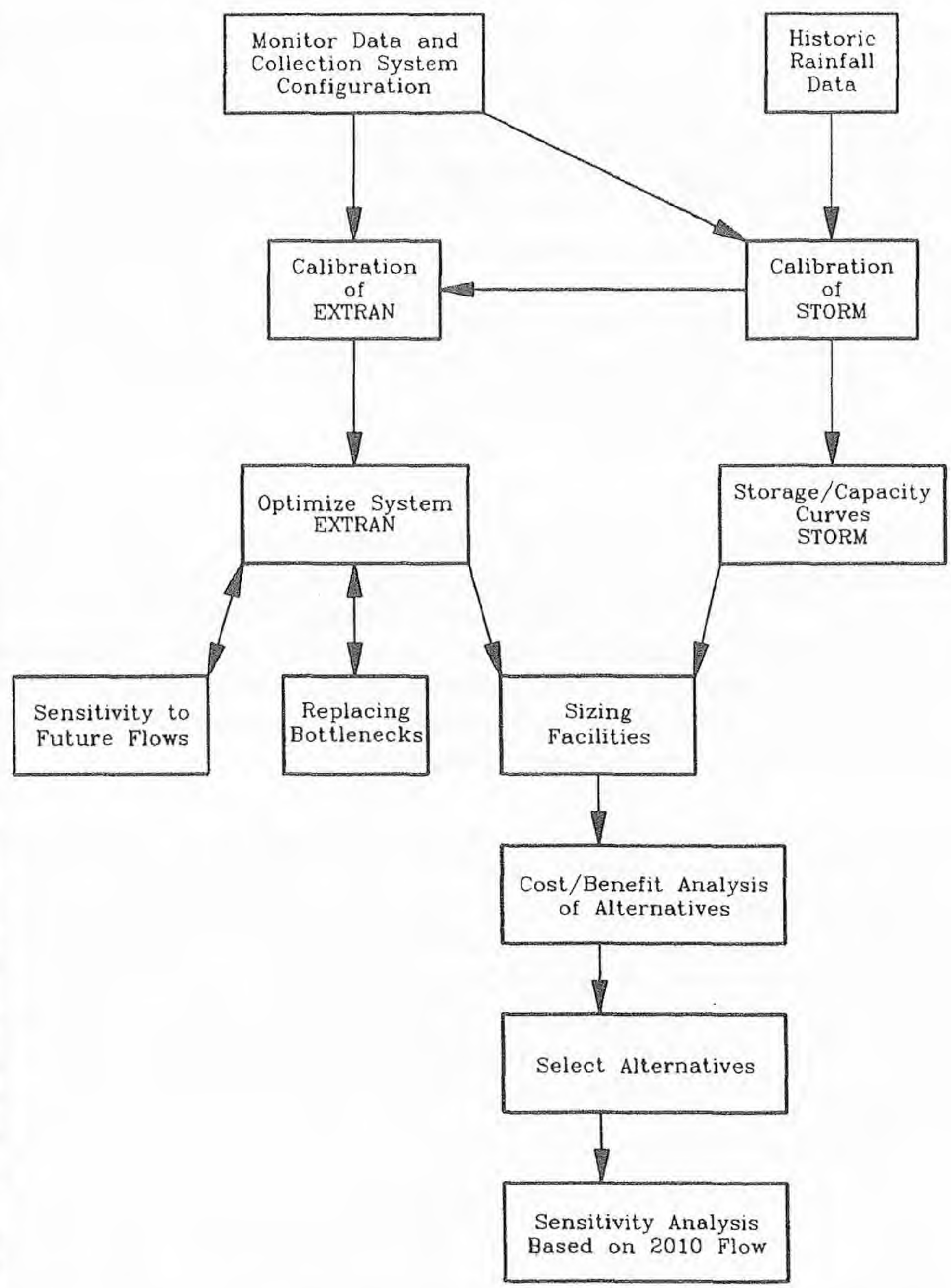

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FIGURE 4-3

MODEL CALIBRATION AND ALTERNATIVES EVALUATION

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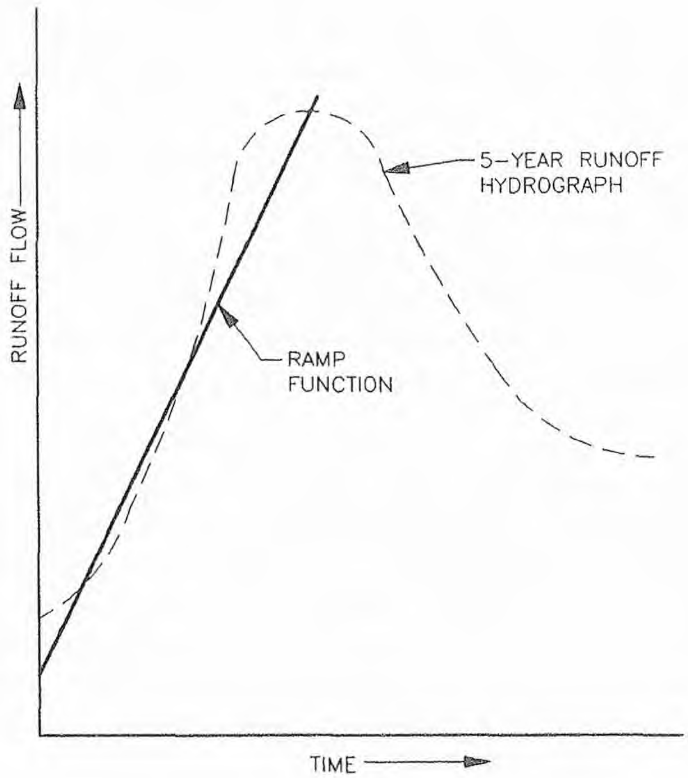
4.4.3 Storm Water Management Model

The EPA's dynamic SWMM simulates the hydraulic response of complex interceptor systems to hydrologic events. Modeling utilized the extended transport (EXTRAN) portion of the SWMM in conjunction with input of runoff based on subbasin characteristics (developed with the STORM). The database used to construct the pipe network in the SWMM was adapted from the SNAP. Hydrologic information input to the SWMM uses an input file called a ramp. The ramp simulates the rising limb of a hydrograph as a steady increase in flow up to a maximum value of precipitation and the resulting runoff for the basins contributing flow to the modeled interceptor system. A graphic representation of a ramp function is shown in Figure 4-4. Additional information on the ramp and the SWMM, and the ramp flows for each model load point for the year 2010 for a 1-year storm are found in Appendix H.

4.4.4 Hydrologic Data

Historic precipitation records from Spokane International Airport weather station observations and area rain gages were used in the hydrologic analysis. Ten years of past (1979 through 1988) rainfall data from the Spokane International Airport weather station were used with the STORM to estimate the annual frequency of overflows. Precipitation data collected from area rain gages was used to calibrate the STORM to actual monitored flows. These flows were recorded during the November 1991 monitoring period of the CSO and interceptor monitoring program (see Appendix B).

Runoff from snowmelt was also modeled using the STORM program. The model was calibrated to snowmelt events that occurred in January 1991. Meteorological records from the Spokane International Airport weather station for 1979 through 1988 were used to model snowmelt runoff after calibration. The STORM snowmelt simulations were found on average to predict about 30 percent higher annual overflow volumes than simulations neglecting snowmelt. Therefore, snowmelt may have an impact on detention facility sizing. Snowmelt will not control interceptor sizing, however, since snowmelt-caused overflows have a limited peak flow rate (Stahre and Urbonas, 1990). Snowmelt data is given in Appendix I.



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CITY OF SPOKANE WASHINGTON FOUNDED IN 1881	**CITY OF SPOKANE** COMBINED SEWER OVERFLOW REDUCTION PLAN	**FIGURE 4-4**
	Bovay Northwest Inc. Engineers and Architects / **CDM**	**SWMM (EXTRAN) RAMP FUNCTION**

4.4.5 Verifying Model Accuracy

The hydrologic simulation model, STORM, was calibrated using measured flow data from the monitored CSOs noted in Table 4-1. Based on this data, each overflow regulating structure setting was modeled mathematically to ensure that the controlling overflow mechanism was understood for each individual weir. The formula for leaping weirs is presented in Appendix J in the memo dated March 20, 1992. An explanation of leaping weir operation and settings is given in Appendix K. Annual volumes and frequencies were then estimated using a 10-year record of rainfall, snowfall, and temperature. For the sum of the monitored CSO volumes, the difference between the STORM predicted overflow volumes and recorded overflow volumes for November 1991 was less than six percent. Specific calibration information is presented in Appendix E.

The City of Spokane's SWMM Interceptor model was customized using the SNAP and monitored flow data evaluated with the STORM. The CSO regulator structure characteristics in the SWMM were adjusted to agree with monitored data. The SWMM was validated by comparing monitored flows in the interceptor with flows modeled for events of the same intensity. The SWMM was within two percent of the monitored flows in the north river interceptor immediately above the wastewater treatment plant for the storm of June 12 through 13, 1992, a 1.2 year frequency storm event, which is close to a 1-year event.

Records from selected monitored events were utilized in the development of the SWMM model. It was important to match precipitation events for which a relatively complete record of precipitation, collection system flow, and CSO volume were available. With a complete record, the model could be validated for flows simulating existing conditions. Once this validity was established for existing conditions, it was possible to simulate the behavior of the system during the design event when modified with structures for the proposed alternatives, or changes in the input hydrograph of a particular basin due to separation or other estimated source reduction.

The design event was selected to meet the WAC 173-245-040 requirement for reduction to one overflow per year per CSO outfall. Two consecutive days of storms each with a return frequency of less than 1 year may result in a runoff flow rate exceeding that produced by a 1-day, 1-year storm. As a result, to provide conservative estimates that the average annual frequency of overflow will be less than one event per year, the design event was chosen as a conservative 1 year frequency storm event. This magnitude of storm was located on the Spokane intensity versus frequency curve for a 12-hour storm, and found to be 0.79 inches.

4.4.6 Control/Treatment Alternatives Modeling

Control/treatment alternatives were modeled with the SWMM to estimate flows and the resulting hydraulic impacts to the interceptor system. The SWMM was used to evaluate and optimize the hydraulic capacity of the interceptor system. The STORM was used to evaluate the effect that specific control/treatment alternatives would have on reducing volume and frequency at applicable CSO regulators. Once potential facilities were hydrologically and hydraulically sized and cost/benefit analyses completed, the selected alternatives were modeled with the SWMM to determine the proposed system's sensitivity with simulated 2010 flows. The technologies considered for control/treatment alternatives are discussed in Chapter 5.

5

5

BOVAY NORTHWEST

CHAPTER 5. COMBINED SEWER OVERFLOW CONTROL TECHNOLOGIES

This Chapter presents the combined sewer overflow control and treatment technologies considered under this Plan. Chapter 5 includes reviews of currently available technologies for application in Spokane as well as all technologies required by WAC 173-245-040. However, this is not necessarily an exhaustive list of all possible CSO control and treatment technologies. Those technologies that have been applied in Spokane to date are reviewed in this Chapter. The technical and financial practicality of control/treatment technologies are discussed within the Chapter, including:

- Best management practices, such as street surface cleaning, interceptor system flushing, catch basin cleaning, sewer rehabilitation to reduce I/I, pretreatment programs, on-site retention such as using grassy swales, and City wastewater ordinances

- Store and treat, including on-site detention storage, using flow control devices, in-line storage, off-line storage, storage in existing lines, and control with interceptor optimization

- Increased interceptor and additional primary treatment capacity at the SAWTP

- Remote site primary treatment

- Separation, including full and partial separation.

5.1 BEST MANAGEMENT PRACTICES

There are a wide variety of storm water and sanitary sewer flow reduction and management techniques that can be categorized as best management practices (BMPs). Best management practices include street surface cleaning, catch basin maintenance, combined and storm sewer flushing, sewer rehabilitation for inflow and infiltration reduction, water use reduction, grass bio-filter retention swales, and wastewater ordinances directed at source control. All of these practices constitute source controls to some extent, with a common principle of reducing pollutant accumulation on impervious surfaces in the drainage basin, or in portions of the collection system itself to reduce pollutant loadings from untreated CSO discharges during storm events.

5.1.1 Street Cleaning

Conventional street sweeping was studied under the Nationwide Urban Runoff Program (NURP) and was shown to be generally ineffective as a technique for improving the quality of urban runoff. Analysis of data from 10 study sites and a total of 381 storm events monitored under control conditions and 277 events monitored during periods of street sweeping operations indicated that no significant reductions in pollutant concentrations in urban runoff were produced by street sweeping (U.S. EPA, 1983). However, street sweeping may reduce the total sediment load in Spokane, since street sanding to improve traction during the winter is regularly used. The City conducts street sweeping on a semi-annual basis for both litter control and to reduce sediment loading to the wastewater collection system.

A study conducted in Austin, Texas, and published in 1989 documented statistically significant improvements in water quality at a shopping mall located in a groundwater recharge zone after implementation of an intensive street surface cleaning program. The *Stormwater Management Manual for the Puget Sound Basin* (1992) lists several methods to maximize street cleaning efficiency, including using a frequency of at least once per week, with higher frequencies in areas with high pollutant loadings; using vacuum or regenerative air sweepers; enforcing construction site erosion controls; improving street condition; and public education programs.

Vacuum and regenerative air street surface cleaners are relatively new products that are more efficient in removing fine particles. The newer street surface cleaners generally have a higher purchase cost than conventional street sweepers, but when operated to remove fine particles may have a lower maintenance cost because dirt and debris are picked up by air instead of mechanical conveyors. Vacuum sweepers may be purchased with an attachment useful for catch basin cleaning (Public Works, 1992).

5.1.2 Maintenance of Storm Drainage Facilities

Catch basin detention has traditionally been viewed as a means to storm water quality enhancement. Catch basins are somewhat effective in attenuating peak storm runoff flows. NURP studies indicate that dry basins do not detain storm water long enough to improve water quality; without frequent cleaning catch basins can serve as collectors for dust and debris which can become entrained in the storm sewer flow during a storm event (U.S. EPA, 1983). With infrequent cleaning, the benefit of catch basins in attenuating peak storm flows may be outweighed by the deterioration in CSO quality due to dust and debris entrainment in catchbasins. *Stormwater Management Manual for the Puget Sound Basin* maintenance standards include catchbasin cleaning if the depth of deposits are equal to or greater than one-third of the depth from the bottom of the basin to the invert of the

lowest pipe into or out of the basin (Ecology, 1992A). This may mean cleaning catch basins on a weekly basis in autumn due to leaf and dust accumulation in street gutters and catchbasins. The City Wastewater Maintenance Division now inspects and pumps only those catch basins and dry wells on slopes on a yearly basis, about four percent of the total. Catch basins are the only facilities that are not under the city's maintenance and management program.

Combined sewer flushing may be used to re-suspend deposited sewage solids and transmit these solids to the dry-weather treatment facility before a storm event flushes them to a receiving water. An EPA feasibility study revealed that no significant gain in the fraction of the load removed was achieved by repeated flushing and 70 percent of the flushed solids will quickly resettle (U.S.EPA, 1979). Therefore, combined sewer flushing does not appear to be a viable action for CSO reduction. The City generally inspects and cleans sewer lines every other year. The City utilizes and maintains a computerized collection management system to plan and coordinate sewer maintenance work.

5.1.3 Flow Reduction

Flow reduction techniques maximize the effectiveness of collection and treatment systems by reducing extraneous sources of water. Infiltration, which is groundwater entering sewers, can be reduced by maintaining, repairing, replacing, or lining older pipes. Inflow is water which enters sewer lines through roof leaders, yard and cellar drains, roadway inlets, and depressed manhole covers. Methods for reducing inflow include discharging roof and area drainage onto pervious land, use of grassy swales and surface storage, raising of depressed manholes, and replacing vented manhole covers with solid covers.

Attenuation of peak runoff and therefore peak inflow to the combined sewer system can be attained using detention storage on streets and rooftops accomplished with appropriate structural modifications. Detention of the first one-half inch of storm water on roof-tops in this area would result in no runoff from roofs for all but two storms on average per year (analysis of National Weather Service data for Spokane from 1979 through 1988). For example, roof-tops account for approximately one half of the surface area in the central business district of Spokane; roof-top detention would therefore effect a significant reduction in peak storm flow to the CSO in this area. Modifying existing structures for retention of storm water on rooftops may entail increased liability for the building owner due to the potential for structural damage and leaks; it should be used only as a last resort for CSO control.

The City is currently following an aggressive infiltration reduction program in the central business district by lining older pipes. Infiltration reduction reduces the base wastewater

flow by curtailing groundwater infiltrating the wastewater collection system. Any reduction in base wastewater flow will tend to reduce the frequency and volume of overflow at CSO regulating structures. Continuation of the city's current policy is therefore beneficial to CSO reduction. Future infiltration reduction efforts might be focused in combined sewered areas as a best management practice to reduce overflow frequency and volume.

City-wide inflow reduction efforts include requiring new development to retain the first half-inch of storm water runoff in grassy swales. As a further inflow control measure some solid manhole covers have been installed, particularly in the vicinity of Latah Creek. Since inflow contributes to peak storm water flow, reduction of inflow in combined sewered areas reduces the frequency and volume of overflows. Future inflow reduction efforts might be focused in combined sewered areas as a best management practice to reduce overflow frequency and volume.

Another flow reduction technique is demand management, including minimizing water usage through shower head retrofit, toilet tank modification, and consumption based water and sewer rates. Other water use reduction techniques such as lawn watering restrictions and commercial toilet retrofit have been shown to have comparatively minor effectiveness in a study by the City of Seattle Water Department (1990). Reducing lawn water runoff to the sewer system might have a more significant effect in Spokane, as the irrigation season is longer in this area. A potential drawback is that reduced flows may increase the concentration of hydrogen sulfide gas and the resulting deterioration of pipes.

5.1.4 On-Site Retention Swales

On-site retention grass swales have been used in the City in on-site parking areas and along streets to retain and treat the first one-half inch of runoff carrying the highest load of pollutants and nutrients. To increase grass retention swale longevity and effectiveness oil/water separators and erosion controls should also be employed where necessary. Retention swales, also called water quality infiltration basins, are designed to have a maximum depth of 6 to 8 inches of water during a runoff event. The grass and underlying soil intercept pollutants by adsorption, acting as a bio-filtration system to prevent contamination of groundwater.

This technique can be used to prevent storm runoff from reaching combined sewers, by infiltrating into the ground through a thick, well tended grass sod layer. Grass swales could reduce storm flows during the growing season significantly by retaining storm water either on the site or in a lot close to the area of rainfall. During the winter months, when grass is covered with snow or ice, runoff is not intercepted by swales.

The storms with the heaviest pollutant loads as well as the greatest peak volumes occur during the summer in Spokane. Figure 5-1 is an illustration of an on-site retention swale. Additional design and performance information on grass retention swales can be found in the *Stormwater Management Manual for the Puget Sound Basin* (Ecology, 1992).

5.1.5 Wastewater Ordinances

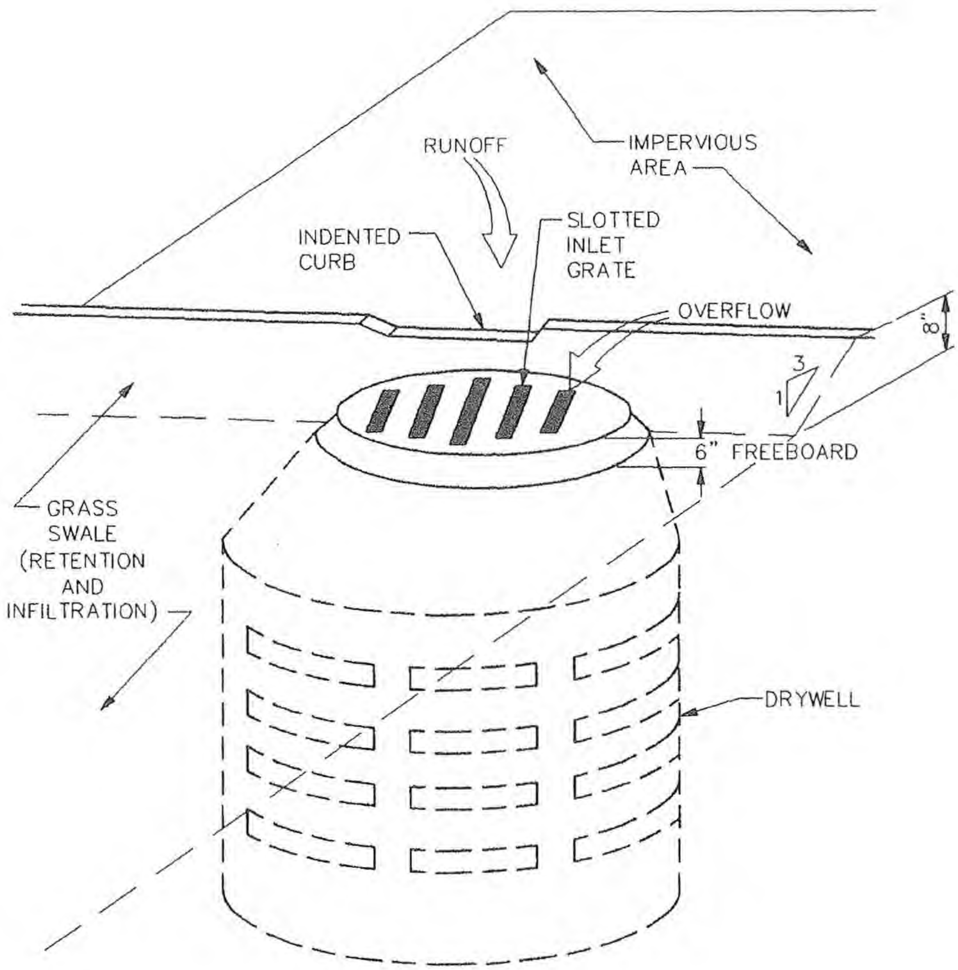
There are several approaches to ordinances restricting connections to wastewater collection systems. The following paragraphs outline some of those approaches, including the existing policy of the City and ordinances passed by the City council.

An example of a restricting ordinance is Seattle's Grading and Drainage Ordinance. To comply with the ordinance, any new construction or redevelopment in Seattle of a property exceeding 2,000 sq ft (750 sq ft was proposed as of 1988) is required to submit a drainage control plan with their construction documents for permit application. Plans must specify the means for on-site drainage control in areas where receiving drainage systems are inadequate. Discharge of peak flow from developed properties must not exceed 0.2 cfs per acre for 10 year storms and discharge locations or means must be specified (Brown and Caldwell, 1988).

Historically, land use controls focused at mitigating CSOs have typically not been used. The relatively large areas of land required for significant storm water infiltration and for the reduction of the rate of runoff are generally not available in the older, more densely developed portions of municipalities that are served by combined sewers (WPCF Task Force on CSO Pollution Abatement, 1989).

Current City policy states that re-development of properties greater than 6,000 sq ft within areas of the existing combined sewer system will follow the City's drainage policy, which generally specifies that on-site retention will be provided for up to one-half inch of runoff from impervious surfaces. Runoff in excess of the volume of the initial one-half inch of runoff may overflow to dry wells. The City's runoff ordinance specifying what are known as grass swales is outlined in Appendix G.

A general ordinance requiring on-site retention of storm water using grass swales can not be practical in areas of dense development, high water table and/or shallow basalt rock. However, if detention storage were required for significant impervious surfaces, either on rooftops, in basements, or under parking lots, peak runoff can be considerably reduced. This ordinance alternative could reduce peak flows to the overflow regulating structures and thus the treatment plant. Additional information on one means of detention storage is presented in the following section addressing storage technologies.



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CITY OF SPOKANE COMBINED SEWER OVERFLOW REDUCTION PLAN		FIGURE 5-1
Bovay Northwest Inc. Engineers and Architects	CDM	ON-SITE RETENTION SWALE

5.2 STORAGE AND TREATMENT

Storage options detain storm flows to reduce peak flows in the combined sewer system and therefore reduce CSO volume and frequency. Storage facilities are designed to allow flow back into the combined sewer system either at a reduced rate or after peak storm or sanitary flows have passed, or stored combined wastewater may be routed to alternative treatment facilities. Detained wastewater is conveyed to a treatment plant for processing.

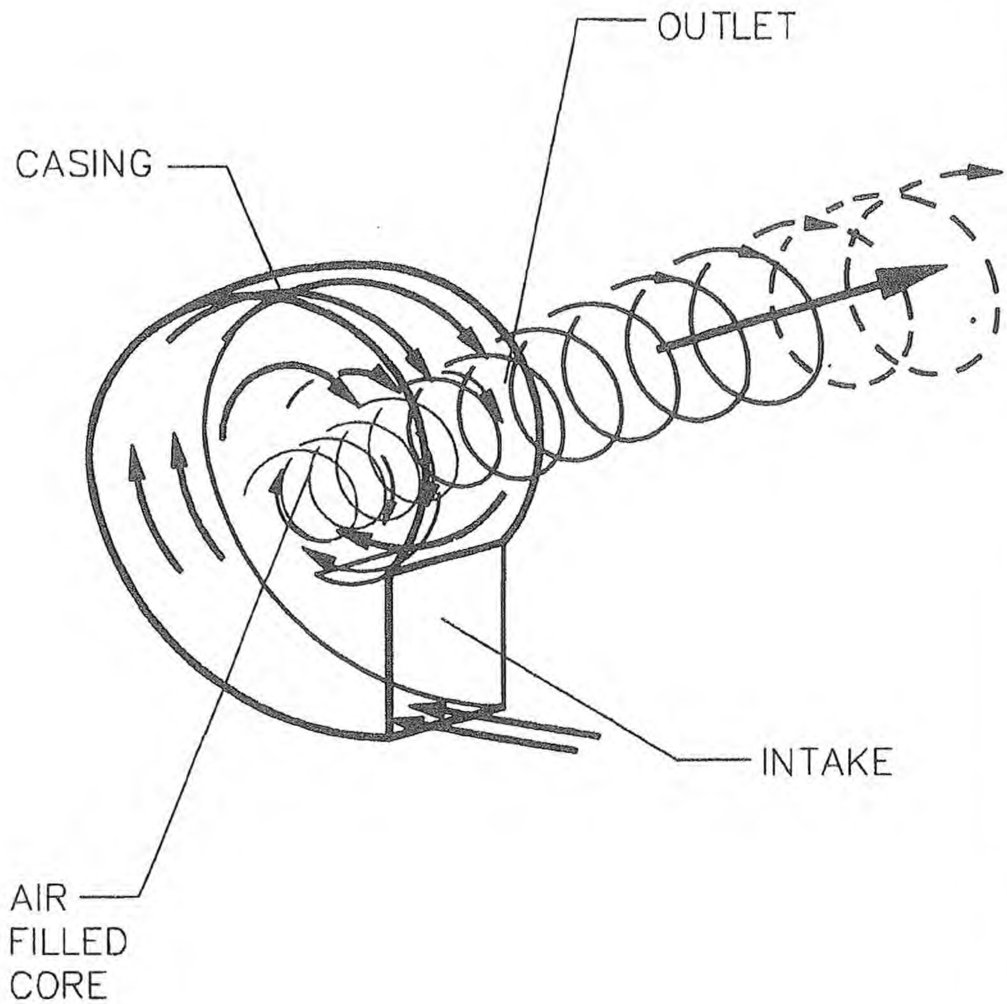
A major factor in determining the feasibility of storage is land availability. The facilities may be located near overflow points, a treatment facility, or a major interceptor which is at or near capacity prior to construction of storage. CSO regulating structures located upstream or downstream of a storage facility along the same interceptor can be adjusted to maximize flow to the interceptor, thus reducing the frequency and volume of overflow.

5.2.1 Flow Control Devices

Flow control devices are necessary in storage facilities to control flow into and out of a storage facility. Influent control facilities prevents overloading of the interceptor downstream of the storage facility. Effluent control enables a timed return of wastewater to the interceptor that coincides with lower sanitary flow. An overflow control device is also required on the storage facility to protect the effectiveness of the storage facility, control flow to remote-site treatment facility and protect the facility site.

Examples of flow control devices used with detention or storage include side-overflow weir structures, automatic gates, pumps, and vortex valves. The simplest regulating structure is a side overflow weir, now in use in several locations as described in Table 1-1. Automatic gates include inflatable rubber dams, drop gates, and several types of mechanically controlled gates. Electronic controls for rubber dams and drop gates can be part of a computer control network with rain gages and flow monitors, which signal the controller that a storm is in progress and enable automated, programmed control of storm water flow.

A vortex valve can be used to control effluent flow from a detention or storage facility. The valve has no moving parts, low maintenance requirements, and is self-activating. The flow pattern is shown in Figure 5-2. Figure 5-3 illustrates a typical stage discharge curve. One advantage of this control device is that in an in-line storage facility the valve allows a first flush which will discharge the accumulated solids to the treatment plant before restricting the flow.



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CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN

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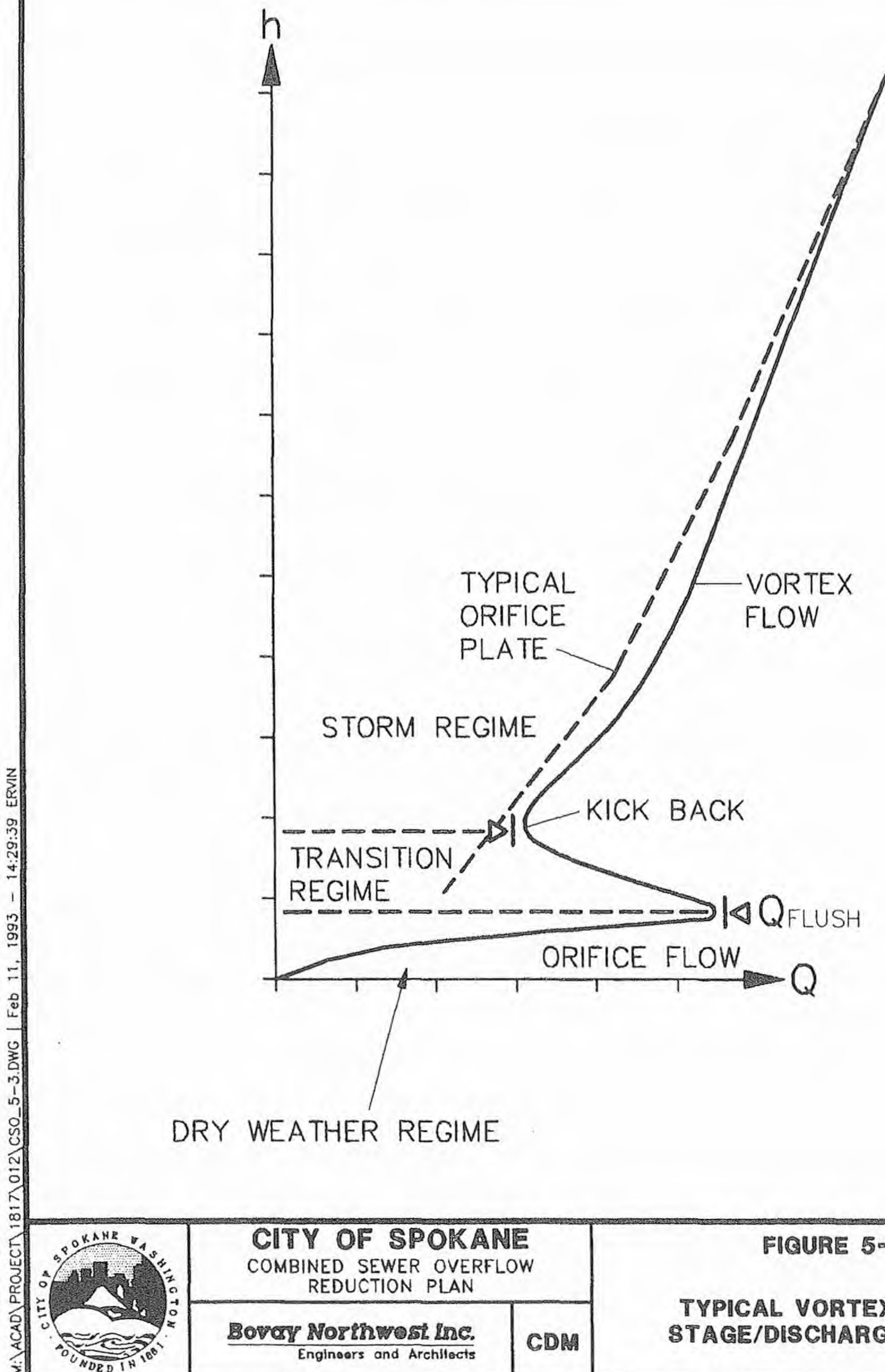
FIGURE 5-2

VORTEX VALVE FLOW PATTERN



CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN

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FIGURE 5-3

TYPICAL VORTEX VALVE STAGE/DISCHARGE CURVE

5.2.2 On-Site Detention Techniques

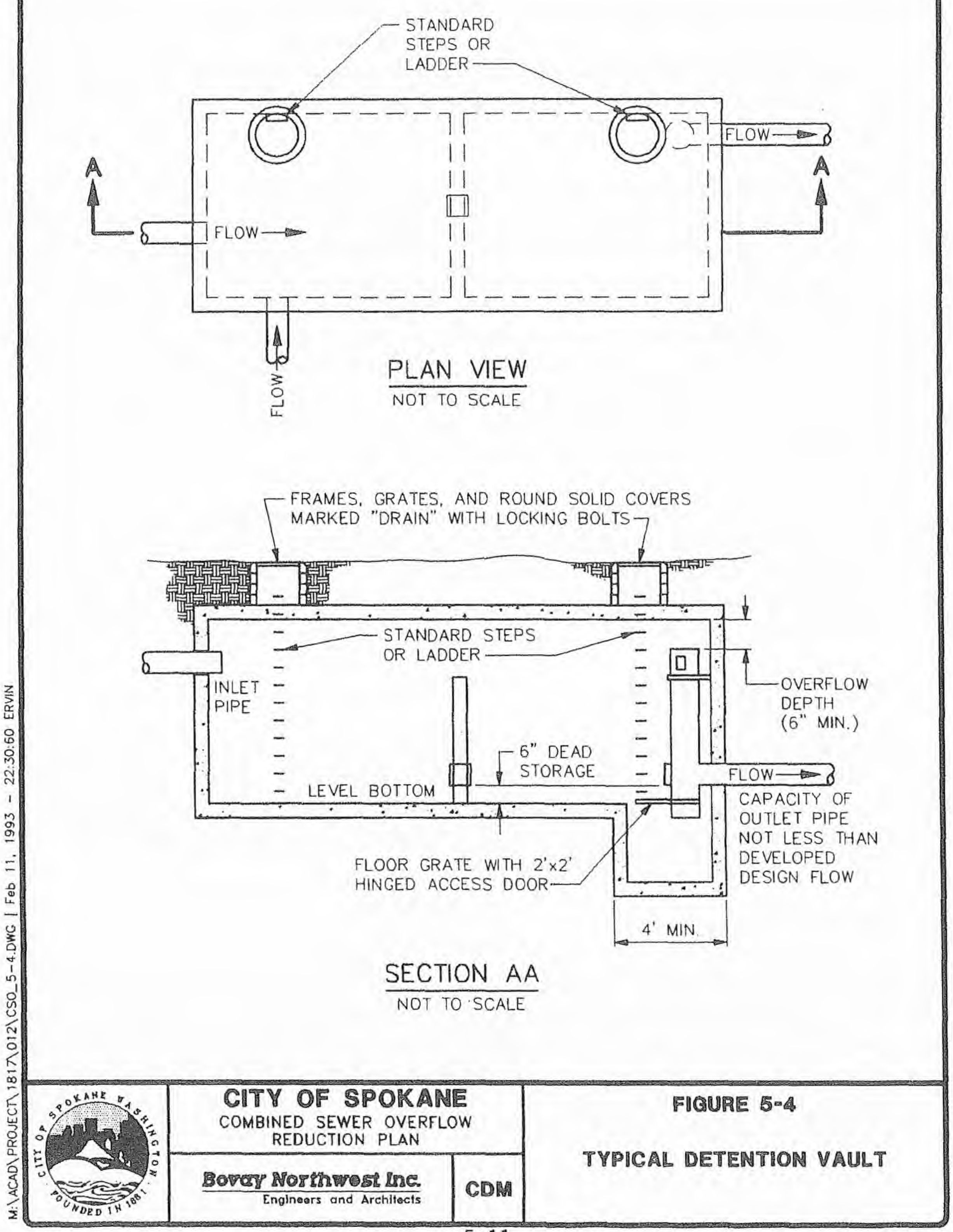
On-site detention reduces peak flows and lowers frequency and volume of overflow at existing regulator structures. However, some regulator modification might be needed in addition to detention to achieve one event per year frequencies.

On-site detention was studied under NURP as a means of improving water quality of urban runoff. The NURP study data indicated that wet basins, those with ponded water during dry weather, were the most effective at diluting first flush pollutant loads. However, in many urban areas, such detention techniques are generally expensive and land intensive. A lower cost alternative is to provide "dual-purpose" basins which are conventional dry basins with modified outlet structures which significantly extend detention time (U.S.EPA, 1983). Dual purpose basins both reduce pollutant concentrations in the first flush of storm water and attenuate peak flow. Dry basins can be catch basins, flat rooftops, parking lots, above ground basins, or underground pipes or tanks. The City now requires the use of retention prior to inflow to dry wells in all new developments. In older residential areas the City makes extensive use of dry wells for storm water control, and as indicated in Chapter 4, this usage may have a negative impact on the Spokane Aquifer. Figure 5-4 is a representation of typical wet or dry detention vaults adapted from the *Stormwater Management Manual for the Puget Sound Basin* (Ecology, 1992A).

5.2.3 In-Line Storage

In-line storage structures force all treatment plant-bound flow to pass through the structure first. The flow out of the structure is then regulated by a flow control device. The use of gravity flow control devices is only feasible when gravity flow into the subsequent line is possible.

There are several types of in-line storage, such as pipe packages, concrete detention basins, underground tunnel storage, and storage in existing lines. Existing lines are treated separately since storage in them requires a different hydraulic model from the other in-line storage types.



CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN

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FIGURE 5-4

TYPICAL DETENTION VAULT

For gravity driven flow, outflow from the storage facilities can be regulated by automated gate valves or vortex valves that maintain nearly constant flow rates. Whenever the inflow rate exceeds the outflow rate, combined sewage is stored in the basin, and when the inflow rate is less than the outflow, the stored wastewater is released to treatment. If diurnal flow variations can be predicted, the outlet rate can be pre-set to balance out all of the flow peaks and valleys during the average day (Stahre and Urbonas, 1990).

Whenever unusually heavy flows occur, the storage volume will be exceeded. This will cause the basin to overflow, and the flow will continue downstream to the next storage basin or the treatment plant. Because of the likelihood of this happening in a combined wastewater system, it is a good idea to provide an emergency overflow spillway that discharges to a water body (Stahre and Urbonas, 1990). Ecology recommends in *Criteria for Sewage Works Design* that "provision should be made to store the peak flows of the maximum possible design storm and then return flows evenly into the system" (Ecology, 1985). As a result of releasing less overflow by retaining more wastewater in the system, in-line storage as described above will cause an increase in total flows to the treatment plant.

For gravity flow to be feasible, the site needs to have sufficient vertical gradient to allow some head loss through flow regulating structures into and out of the storage chamber; otherwise supplemental pumping is required (Stahre and Urbonas, 1990). Wastewater management operators may utilize pumping as a means of controlling the flow rate into the treatment plant.

5.2.4 Storage In Existing Lines

In-line storage in existing lines differs from the in-line storage discussed above in that only the existing sewer line can be used for a storage structure. In-line storage in the existing lines can be facilitated by an automated gate in a new chamber. Sufficient head must be available in the existing line to allow for the added hydraulic impedance of a control structure present even when fully open.

5.2.5 Off-Line Storage

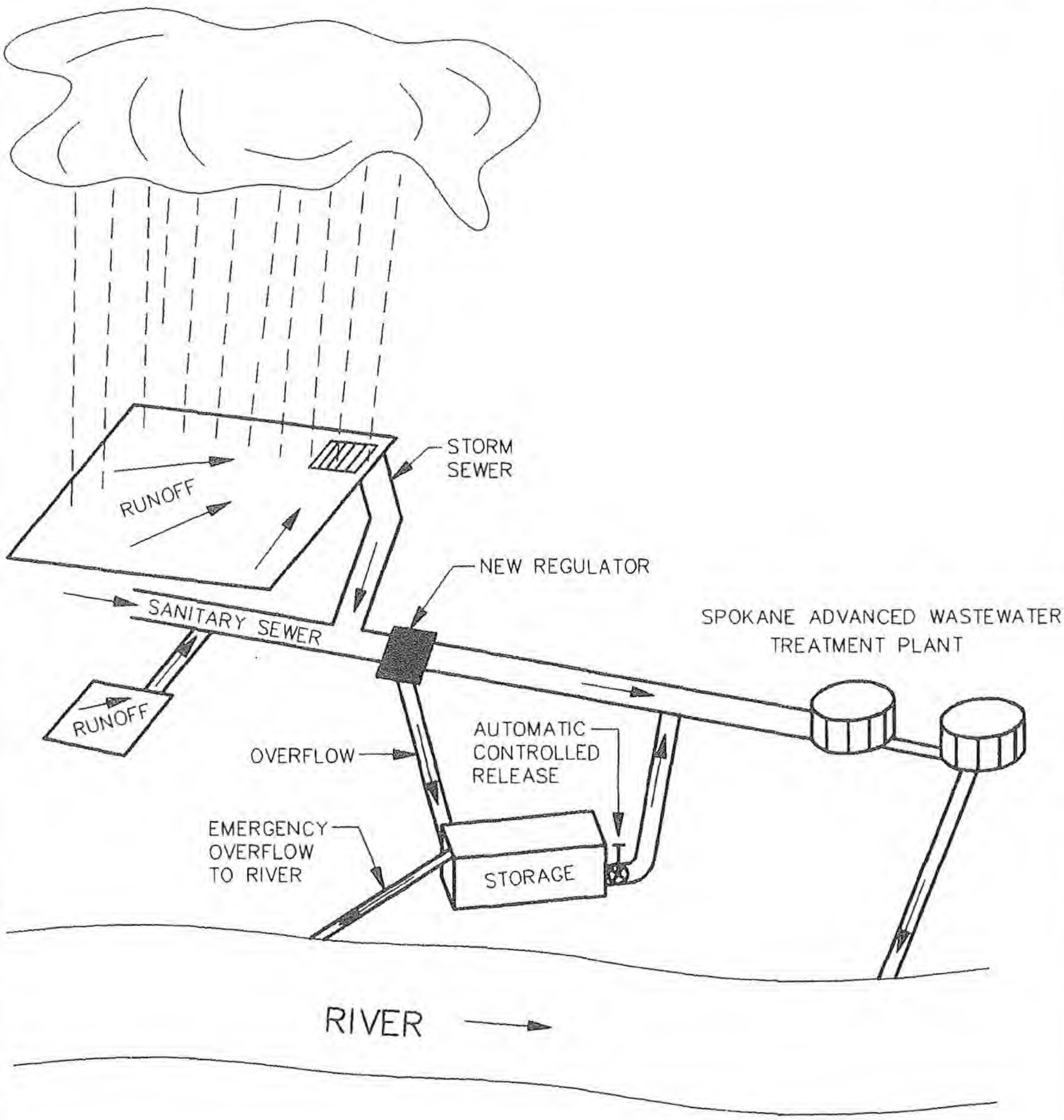
The major objective of off-line storage is to detain intermittent large volumes of storm water for controlled release into central or remote treatment facilities. Off-line storage facilities are constructed parallel to the interceptor sewer instead of in-line. Off-line storage provides a more uniform flow than in-line storage, which defers the need for and/or the magnitude of additional treatment facilities. The inflow to the storage facility is regulated by a specially designed side channel spillway, which could be similar to the

existing side-overflow weirs now in use in the City's system. The water that is stored in the facility flows by gravity or is pumped to the main interceptor flow stream when the inflow rate falls below a pre-set rate (Stahre and Urbonas, 1990). Figure 5-5 shows an example of an off-line storage configuration. As with in-line storage facilities, off-line storage structures may include concrete storage basins, or underground tunnels. In addition, off-line storage may include pipe packages. Land availability and location considerations described at the beginning of Section 5.2 are also applicable to off-line storage.

A parallel pipe package is a set of large diameter pipes laid parallel to the combined sewer pipe. Flow is diverted from the combined sewer line into the first parallel pipe at a pre-set level. Flow is subsequently diverted to successive pipes within the package as necessary to store the flow. Restricted flow from the pipe package is allowed to flow back to the combined sewer line downstream of the initial diversion.

The off-line arrangement permits wastewater flow in the interceptor up to a design rate, then flow is diverted to the storage facility. Since storage occurs only when flows spill into the basin, off-line basins are less prone to sludge accumulation than in-line basins (Stahre and Urbonas, 1990). However, in some cases pumping may be required to completely clear the storage facility of stored wastewater. In New York City, the East River CSO Facility Plan recommends off-line storage as the most viable, constructible and cost-effective alternative. Three underground storage tanks are proposed ranging in size from 7 MG to 12 MG at an estimated cost of $172 million, or $6.00 per gallon of stored wastewater. New storage tank installations in the Spokane area, by comparison, are estimated to cost about $1.10 per gallon of stored wastewater capacity.

Other storage facilities have been built under parks. In New Bedford, Massachusetts, tennis and basketball courts were built on top of a 20 MG storage facility, and in Chattanooga, Tennessee, a consolidation and transport tunnel was constructed under a city park in 1992. The tunnel has a volume of 3.7 MG with outlet control back into the interceptor through a vortex valve. Construction cost was slightly over $1.00 per gallon at $4.9 million (Heiser and Cannella, 1992). The cost of this structure is still relatively high.



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CITY OF SPOKANE
COMBINED SEWER OVERFLOW
REDUCTION PLAN

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FIGURE 5-5

TYPICAL OFF-LINE STORAGE
FACILITY SCHEMATIC

5.2.6 Combined In-Line and Off-Line Storage

In some cases in-line and off-line storage arrangements can be combined to work together and function as a single unit. One basin would function as an in-line unit, providing storage during smaller storms. During larger storms, once the in-line basin filled to capacity the off-line basin would fill, providing additional storage and confining the most highly polluted storm water in the in-line basin. Pollutants other than large particle sediments would be easier to flush to the central treatment plant from the in-line basin.

5.3 INCREASED INTERCEPTOR AND TREATMENT PLANT CAPACITY

Increasing interceptor capacity allows for adjustment of regulating weirs so that more combined wastewater flows to the interceptors. Increased flow in the interceptors increases the flow requiring treatment. Options for increased capacity include replacement of existing pipe with larger diameter sewer pipe or construction of relief sewer paralleling the existing line. Changes at the treatment plant would include modification of the headworks and increased storm water treatment capability in the storm clarifiers and disinfection facilities.

5.3.1 Control/Treatment With All Regulators Overflowing Once Per Year

It is possible to modify all CSO regulators to allow only one overflow per year. The interceptor and treatment plant capacity would be increased to accommodate the resulting increase in intercepted wastewater flow that would occur during storm events.

5.3.2 Control With Interceptor Optimization

Weir regulating structures are the existing means for CSO control. There are three principal types of weirs now used in Spokane: leaping weirs, side overflow weirs, and diversion dams. Leaping weirs are the most prevalent structures, with 20 in the system. There are now eight side-overflow structures and two diversion dams in the City's combined sewer system.

Adjustments to the existing structures have been primarily driven by interceptor capacity. Overflow adjustment can be used to reduce annual CSO frequency and volume. Overflow modifications to optimize interceptor capacity may be combined with other controls to achieve the one overflow per year goal.

Allowing more flow to enter the interceptor by modifying CSO weir regulators implies that additional peak storm event volume will reach the SAWTP, unless the flow rate is attenuated or diverted upstream of the SAWTP into a storage or treatment facility.

Interceptor optimization is evaluated with increased interceptor capacity storage and treatment.

5.4 PRIMARY TREATMENT OPTIONS OTHER THAN THE SAWTP

Three alternative treatment methods of combined sewer overflow at sites remote from the SAWTP are outlined in this section. These methods are currently being used in other cities with combined sewer overflows: storage/sedimentation basins, fine screening, and swirl/vortex concentration. All remote site primary treatment options would return concentrated wastewater to the SAWTP. All remote site primary treatment options would be subject to WAC 173-240 requirements for meeting water quality criteria. At this time WAC 173-245 has set one treatment requirement specifically for CSO discharges, to reduce TSS by 50 percent. The treated combined sewage discharge at the SAWTP is permitted a monthly average fecal coliform count of 200 per 100 ml sample with a monthly average total residual chlorine concentration of 8 micrograms per liter (μg/l) during the low flow season from July through October (Ecology, 1992B). All alternative methods would require disinfection, which may be chlorination/dechlorination.

5.4.1 Storage/Sedimentation

The mechanism of treatment for storage/sedimentation basins is particle settling. Particle settling depends upon a detention time long enough in a basin shallow enough for particles to settle out of the wastewater prior to discharge or further treatment. As a result, sedimentation basins are often constructed with baffles to increase detention time and improve efficiency. Typical removal efficiency for TSS concentrations characteristic of CSO (150 mg/l) for 2 hour detention in a storage/sedimentation basin is 60 percent (Stahre and Urbonas, 1990). As noted in the sub-section on off-line storage, pumping may be required to completely clear the facility of stored wastewater. Some storage facilities are now designed with a washdown system to flush settled solids to the treatment plant. [Maintenance costs for this kind of treatment facility are generally low; for example, a 2 MG facility in Saginaw, Michigan costs approximately $5,000 per year (1992 dollars) to operate and maintain (U.S. EPA, 1986)].

5.4.2 Fine Screening

A fine screening device adapted for CSO consists of a fine screen on a rotating drum. Raw influent enters a headbox that extends inside the rotating screen drum. The headbox is designed to maintain suspension of solids and distribute the flow over adjustable weirs onto the slotted sides of the rotating screen drum. Captured solids are collected in the bottom of the drum and are subsequently directed to the discharge end. To remove 50 percent of combined sewer solids, the required screen size is 0.1 inches. For a peak

treatment rate of 20 mgd, 3 screening units in parallel would be needed, each about 16 ft long and 7 ft high. In addition, a storage unit is recommended above the screening facility. No figures were available for O&M of a fine screening facility, but the drum drive motor, spray nozzles, and periodic checks of the screen condition would be the largest O&M costs.

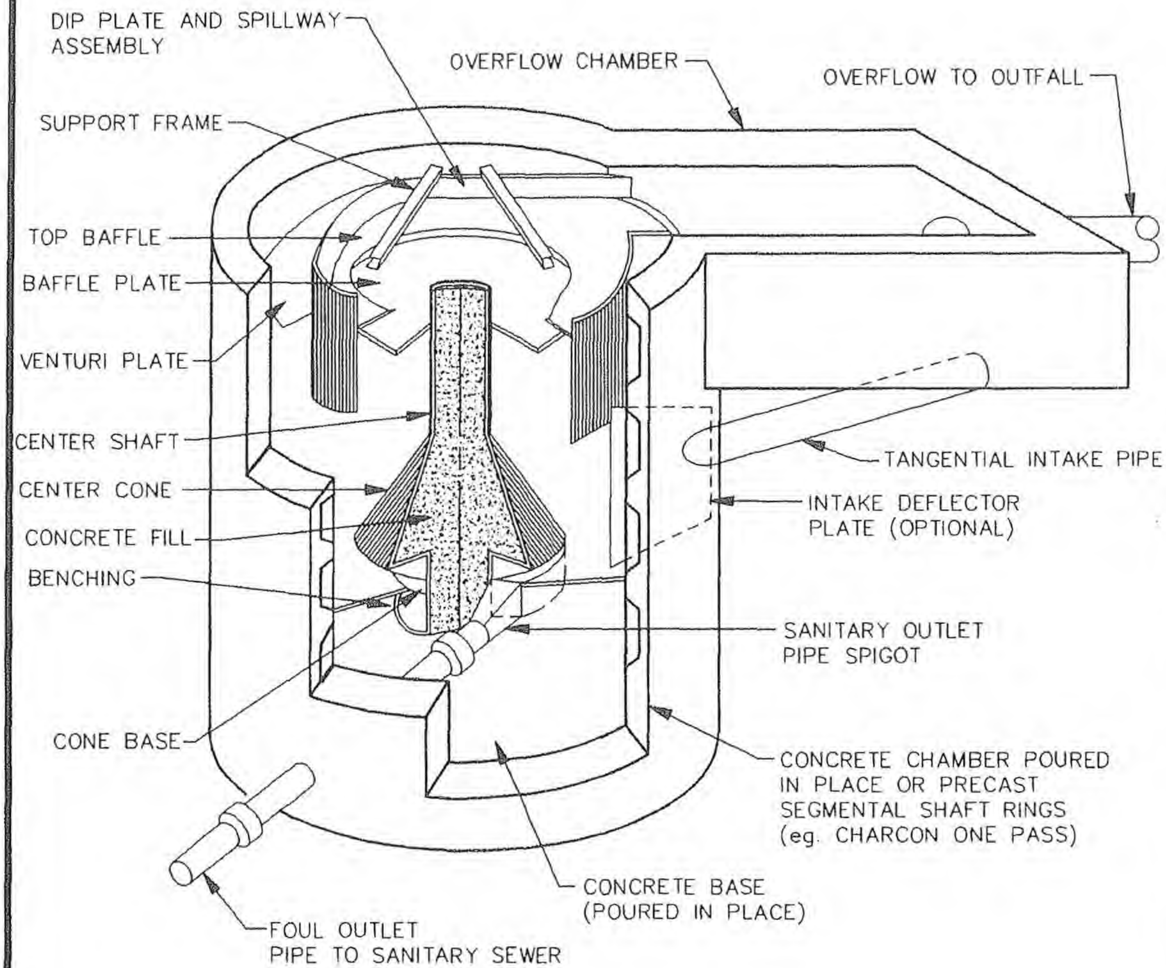
5.4.3 Swirl/Vortex Concentrators

Swirl or vortex concentrators control both the quantity and quality of combined sewage. Circular flow within the facility concentrates solids toward the center and downward. The flow is separated into a large volume of clear overflow and a concentrated low volume of waste that is intercepted for treatment at a wastewater treatment plant. It has a relatively constant treatment efficiency over a wide range of flow rates and has no moving parts. Figures 5-6 and 5-7 illustrate the swirl concentrator. A study in Columbus, Georgia concluded that chemical disinfection of CSOs can be accomplished in a vortex concentrator. The study demonstrated that TSS removals were as high as 80 percent, and since disinfection and solids removal can be achieved in the same unit, capital costs were reduced (Ghosh, et al, 1992). Dechlorination would be an additional installation consideration.

East Bay Municipal Utility District in Oakland, California has a number of wet weather treatment plants which have recently been completed or are under construction. One treatment plant (currently under construction) provides fine screening solids removal and disinfection using high rate chlorination followed by dechlorination. After a storm, solids removed by the screens and grit are returned to the main wastewater treatment plant (WWTP).

Another wet weather treatment facility in Oakland is a 3 MG storage facility. If the storm is large enough that discharge is required, wastewater is disinfected using sodium hypochlorite and dechlorinated using bisulfate. Settleable solids are flushed back to the main WWTP after the storm event. This system is similar to the existing storm event treatment now in use at the SAWTP.

A 300,000 gal swirl concentrator or vortex solids separator followed by a 2.1 MG sedimentation unit and disinfection is recommended to be the most cost-effective CSO reduction alternative in Toronto, Canada. Estimated total annual cost was $1.8 million a year, with the capital cost annualized over 40 years. For comparison, retention storage is estimated to cost $2.8 million a year annualized over 40 years. The vortex and sedimentation is estimated to remove 67.9 percent of solids and 98.2 percent of fecal coliform capture.



NOTE: DIMENSIONS DEPEND ON DESIGN TREATMENT RATE.

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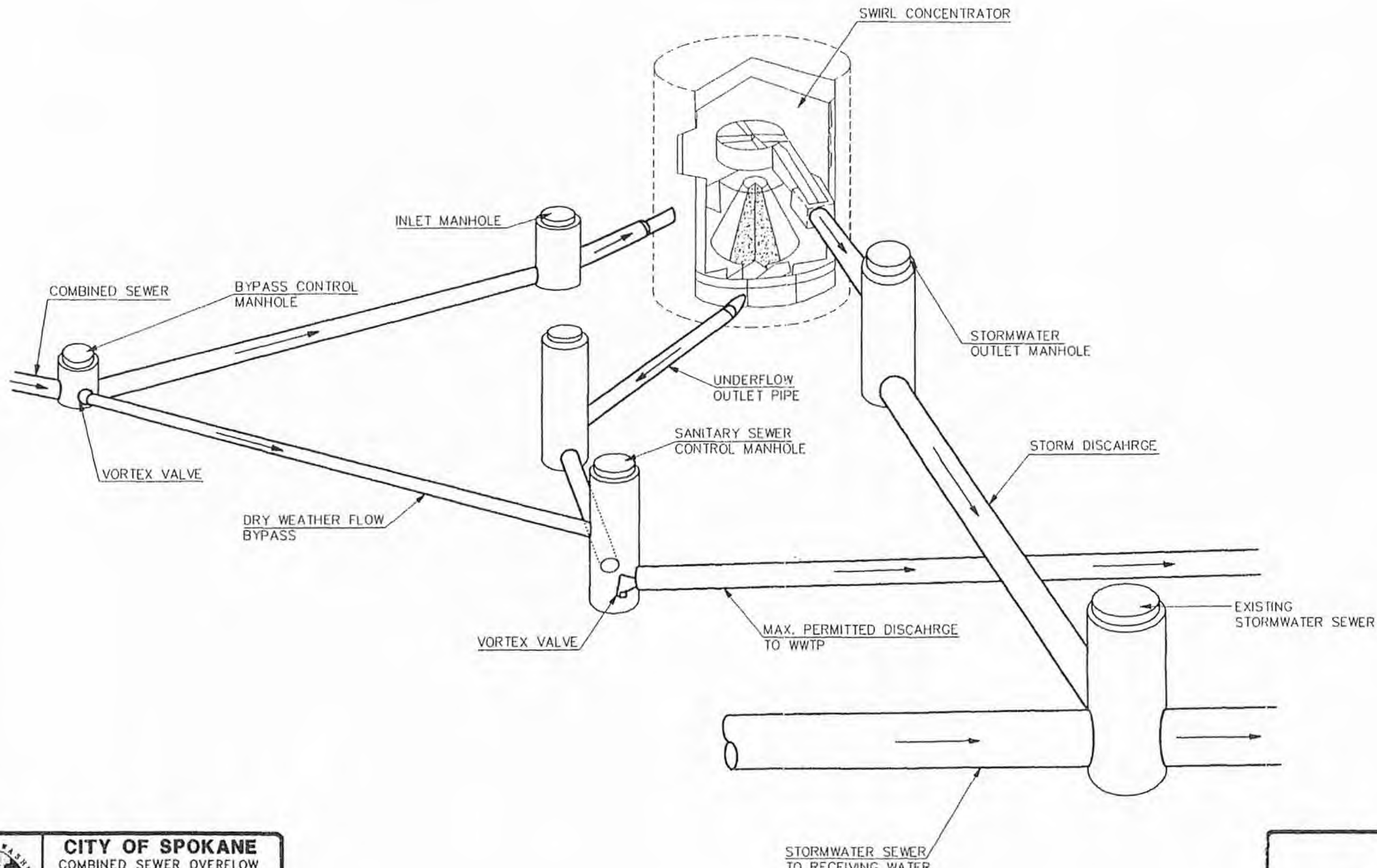
CITY OF SPOKANE COMBINED SEWER OVERFLOW REDUCTION PLAN		FIGURE 5-6
Bovay Northwest Inc. Engineers and Architects	CDM	DIAGRAMMATIC CUT-AWAY OF AN OVERFLOW SWIRL CONCENTRATOR



CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN
Bovay Northwest Inc. Engineers and Architects | CDM

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FIGURE 5-7

SYSTEM SCHEMATIC OF A TYPICAL DYNAMIC SEPARATOR INSTALLATION

5.5 SEPARATION

Sewer separation is the conversion of a combined sewer system into separate sanitary and storm sewer systems. Up to this time full separation has been the method of choice for CSO reduction in Spokane. Separation was the least costly and most feasible way of eliminating CSOs, as mandated by the federal and state clean water laws. Under the latest revision to the Federal Clean Water Act, however, storm water discharge to lakes and streams has become subject to NPDES permitting for populations greater than 100,000. Spokane's current population served by separate storm water collection systems discharging directly to the Spokane River or Latah Creek is approximately 74,000, but all people not served by combined sewers within the City sewer service area count toward the NPDES 100,000 population. Eventually storm water discharges under an NPDES permit may be subject to water quality restrictions, possibly requiring expensive treatment prior to discharge to a receiving water.

Separation can be accomplished by adding a new sanitary sewer and using the old combined sewer as a storm sewer or by adding a "sewer within a sewer" pressure or vacuum system. Adding a new storm sewer is also possible, but this may be more expensive in developed areas because storm sewers usually require larger diameter pipe than sanitary sewers draining the same area. If combined sewers are separated, it must be remembered that storm sewer discharges may contribute a significant pollutant load and may require some type of control or treatment even after the sewers are separated. Separation is more cost-effective in residential areas where population density is low.

5.5.1 Full Basin Separation

Full separation is not generally desirable in industrial or commercial areas with roof drains and basement sumps as well as street storm drains, even though these areas contribute the greatest amount of storm flow in volume per acre. The technical obstacles include identification of all current storm discharges in older areas of the City, some of which do not have accurate records of connections. Adding parallel storm sewers in the downtown area may entail prolonged disruption of traffic and commerce. The existing utilities in the streets in the downtown area are quite dense, adding to the technical difficulty of design and installation. Finally, future regulations may require treatment for storm water discharges, particularly from highly urbanized drainages.

Most of the downtown commercial areas have been surveyed by television camera and a thorough review of this footage would enable identification of most discharge points to the downtown sewers. The other economic and technical considerations outlined above may outweigh this advantage, however, since a cost-effective means of intercepting storm water and excessive groundwater flow may not be available.

5.5.2 Partial Separation

Partial separation differs from full separation in that not all storm water flow is captured in a separate storm sewer. Varieties of partial separation include:

- Roof drains drain to sanitary sewer lines, while all street-level runoff is diverted to separate storm sewers

- Only catch basins in the public right-of-way are intercepted by separate storm sewers, while runoff from private property continues to flow to the treatment plant via sanitary sewer lines

- All runoff from private property is prohibited from entering publicly owned sanitary sewers, but catch basins in the public right-of-way are intercepted by combined sewers

- Portions of a basin are separated either fully or according to one of the above partial separation options.

Street-Level Separation: Depending upon basin land use characteristics, street-level partial separation runoff must be estimated based on roof area within a basin instead of total impervious area. Generally, this partial separation option differs from full separation only in areas of commercial and industrial development, where roof areas comprise a significant percentage of the total area. Older commercial/industrial developments often have existing roof drain-to-sewer connections which are expensive to eliminate or connect to a separate storm sewer. In medium or low-density residential tracts roof area is typically less than 10 percent of the total area, and is often surrounded by lawn or other relatively permeable ground, making these tracts already effective in storm runoff control.

Public Right-of-Way Separation: The second partial separation option would be technically straightforward. However, since a large portion of storm water runoff originates on private property in most commercial and industrial areas, this option may have limited effectiveness for some basins in reducing storm water flows to the combined sewer system and treatment plant.

Private Disposal of Storm Water: The third option could be legislated by City ordinance, requiring land owners redeveloping their property to provide on-site disposal of storm water runoff. The City would have lower storm water disposal construction costs if there was general compliance with an ordinance to dispose of storm water on-site, because the cost would be borne by the property owners. However, as discussed in

Section 5.1, on-site disposal of storm water (this option) would be difficult to accomplish in the central business district. In addition, there may be impacts to groundwater quality from improper on-site storm water disposal. The City ordinance would need to provide an alternative in heavily developed areas like the central business district, such as on-site detention storage. The City may encourage on-site disposal of storm water and conservation through adjustments in the water and wastewater rate structures.

Partial Area Separation: The last option is useful for CSO basins with mixed land uses and as part of an integrated approach to storm water management. The residential tracts can be separated by intercepting catch basins with storm sewers, and commercial and industrial tracts of the same CSO basin can be separated by intercepting public catch basins and requiring land owners to dispose of or detain storm water runoff on-site when sites are developed or redeveloped.

With partial separation, as with full separation, storm water may eventually need treatment prior to discharge. Partial separation has the advantage of reducing storm event flow to the combined sewer system, reduction of CSO frequency and volume and reducing flow to the treatment plant.

5.6 SUMMARY OF CSO REDUCTION TECHNOLOGIES

While a single reduction method may be appropriate for any particular CSO (i.e., storage only or primary treatment only), alternatives evaluated in Chapter 7 of this Plan include strategies using a combination of the following controls:

- Basin-specific best management practices
- On-site retention
- City wastewater control ordinances
- On-site detention
- Storage along interceptors
- Operational modifications including regulator structure modifications
- Continued or strengthened enforcement of the City drainage ordinance.

As part of an integrated approach to CSO reduction, more than one alternative is usually incorporated in areas which require further control in order to achieve the one event per year goal.

Best Management Practices: These are intended to control the sources of storm water and pollutants before reaching the combined sewer system. Such measures range from wastewater ordinances and maintenance and operations practices to construction of local, permeable retention basins or swales to retain and provide acceptable treatment of storm water runoff.

Utilizing Operational Modifications: Utilizing operational modifications such as modifying the opening of a leaping weir along with storm water source reduction achieves the one event per year goal while reducing pollutant loading, thus improving water quality beyond what can be accomplished with partial separation alone. Modifications to existing weirs in conjunction with source reduction in some cases may achieve the one event per year goal, but have an associated treatment cost.

In-line and Off-line Storage: In-line and off-line storage control pollutants by holding runoff for later treatment. In a comparison of separation and storage projects, Seattle Metro's CSO study indicated that storage resulted in significantly lower net loadings of pollutants to receiving waters compared to separation for a similar CSO volume reduction. The storage options increased total Metro CSO control costs by 20 to 50 percent (Brown and Caldwell, 1988).

Primary Treatment: Primary treatment proved to be more cost effective than storage in Toronto. Since advanced wastewater treatment plant capacity is reserved for sanitary wastewater, this option allows more flexibility in adding customers in the area served by the wastewater treatment plant. The limitation is that historically Ecology and the federal government continually create stricter regulations of what can be discharged to the receiving waters. Therefore, municipalities must choose the best current alternative in the face of uncertain future regulations which may make an existing facility obsolete.

Separation Projects: Separation projects reduce volume and frequency of CSOs, but do so by discharging what may be a larger volume of storm water at greater frequency than the CSO. For example, existing storm water discharges amount to nine times greater volume compared to the existing annual CSO discharge. In the existing combined system, most of the storm water and its associated pollutants are diverted to the SAWTP and treated before discharge to the Spokane River.

Table 5-1 summarizes the technologies examined in this Chapter and those discussed as alternatives in Chapter 7.

TABLE 5-1. SUMMARY OF CSO CONTROL/TREATMENT TECHNOLOGIES

Technologies	Feasibility/Pollutant Removal Efficiency
Street Surface Cleaning	High Frequency May Provide Efficient Removal
Catch Basin Cleaning	High Frequency May Provide Efficient Removal
Combined Sewer Flushing	Limited Effect on CSO Quality
Infiltration/Inflow Control	May reduce base flows
Water Use Reduction	May reduce base flows
On-Site Retention	Can Reduce Storm Flow
Wastewater Ordinances	On-Site Control Can Reduce Storm Flow
On-Site Detention	Can Reduce Storm Peaks
In-Line Storage and Control	Prevents Peak Flow from Reaching STP*
Off-Line Storage and Control	Prevents Peak Flow from Reaching STP
Storage in Existing Lines	Effective with Available Capacity
Increase Interceptor and STP	Major Reconstruction of City Lines Possible
Existing Capacity Optimized	Lower Interceptor and STP Costs
Remote Primary Treatment	No Regulations on CSO Treatment
Full Separation	High Cost, May Need Treatment in Future
Partial Separation	Lower Cost, May Need Treatment in Future

* Sewage treatment plant

6

6

BOVAY NORTHWEST

CHAPTER 6. CRITERIA FOR EVALUATION AND ANALYSIS OF CONTROL AND TREATMENT ALTERNATIVES

The purpose of this Chapter is to describe the analysis and evaluation criteria used to screen control and treatment alternatives. These criteria include:

- Water quality and sediment impact
- Impact on the advanced wastewater treatment facility
- Construction and O&M costs
- Economic capability of municipality
- Surcharge of interceptor and interceptor capacity
- Operational impacts due to added complexity
- Future regulations
- Practicality and benefits of phased and integrated implementation
- Compliance with the SEPA.

In Chapter 7, these factors are used to develop, screen, and prioritize projects for each CSO regulating structure. The most important analysis and evaluating factors were water quality and sediment impact. All control and treatment alternatives were screened on the basis of water quality for selection as a control and treatment project. In addition, cost factors such as effect on the wastewater treatment facility, construction and O&M costs, the economic capability of the City, interceptor capacity increases, and operational impacts due to added complexity were all converted to present value costs for ease of comparison. Factors used to screen project options were future regulations and the practicality and benefits of phased and integrated implementation. SEPA compliance is consistent with the primary goal of water quality protection but may result in increased costs.

6.1 WATER QUALITY AND SEDIMENT IMPACT

The WAC 173-245, part 040(2)(c)(i) requires municipalities to include in their assessment of CSO reduction projects "An estimation of the water quality and sediment impacts of any proposed treated discharge using existing background receiving water quality data, and estimated discharge quality and quantity. The department may require a similar analysis for proposed storm sewer outfalls for basins which drain industrial and/or commercial areas" (WAC, 1987). This requirement implies that preference will be given to projects with the least negative impact to receiving water and sediment quality.

To evaluate control/treatment alternatives for the least negative impact to receiving water quality requires comparison on the basis of selected water quality indicator parameters. Indicator parameters were chosen by data availability and applicability to different control/treatment alternatives. As a result, TSS was chosen as the most important indicator parameter. Concentrations of TSS are related to the levels of other water quality parameters of concern, including phosphorus, nitrate nitrogen, five-day BOD and fecal coliforms.

The selected water quality indicator parameter, TSS, has been directly related to CSO volume through monitoring. As a result, water quality concerns are directly addressed by reducing CSO volume. The criterion for sufficient volume reduction is the requirement in WAC 173-245 to reduce CSO to one event per outfall per year. This requirement is first used to size control and treatment alternatives that do not include remote-site treatment or discharge of separated storm water. Following sizing of the potential control and treatment facilities, the frequency and volume reduction benefits of the alternatives are compared.

Storm discharge impacts resulting from separation are evaluated by converting storm volumes of TSS to an equivalent CSO volume of TSS. Analysis of City sample data indicates that the TSS concentrations in CSO and storm water are nearly equivalent; this conservative comparison leads, for the purpose of evaluation, to equating the water quality impacts of one gallon of storm water with one gallon of CSO. Other water quality parameters were not used as evaluation factors for separation, since mass balance comparisons for other parameters are less conservative than that described for TSS.

Remote-site treatment alternatives were evaluated against the definition in WAC 173-245 that primary treatment "means any process which removes at least 50 percent of the total suspended solids from the waste stream, and discharges less than 0.3 ml/l/hr. [sic] of settleable solids."

Details of water quality and sediment impact analysis can be found in Chapter 4, Appendix C, and Appendix L.

6.2 EFFECT ON ADVANCED WASTEWATER TREATMENT FACILITY

Several of the control technologies under consideration would affect costs incurred at the SAWTP. These technologies are:

- All storage alternatives where storm flow would be routed back to the interceptor
- Increased interceptor capacity and additional primary capacity at the SAWTP
- Weir control reduction of CSO to the one event per year goal
- Remote Site Treatment

Sanitary wastewater flows to the SAWTP are expected to increase over the next 20 years partly due to expansion of services to existing development currently served by on-site wastewater treatment facilities. It is mandatory that capacity be reserved for sanitary flow to provide for regional service. Every gallon per day (gpd) of treatment capacity used to treat storm water will be assessed for the sanitary wastewater revenue value. Based on present facility costs for expansion, this assessment is $6.00 per gpd to meet requirements for construction of added treatment capacity. About 90 percent of the existing treatment plant capacity is either in use or is committed for treating wastewater flow from existing development scheduled for sewer construction within the next 20 years.

Storage Alternatives: These would increase cost even though flow can be detained until low sanitary flow hours and then gradually returned to the interceptor. This is due to the cost of treating increased average wastewater flow.

Building storage indirectly impacts the treatment plant hydraulic capacity, affecting the average permitted flow at the treatment plant. Stored wastewater eventually needs to be discharged to the SAWTP or other treatment facilities. Routing stored flows at a controlled, lower rate back to the SAWTP would result in a decrease in available capacity during some periods following a storm event. If SAWTP is already at rated average capacity and expansion at SAWTP is not feasible at the time storage is constructed, an alternative such as remote-site treatment would be required.

Optimizing Interceptor Capacity: This can be achieved by adjusting CSO regulators which may increase flow to the SAWTP. This increased flow would require capacity increases to some of the interceptors and portions of the treatment plant. Optimization has been used by the City to safely refine the efficiency of the interceptor while

minimizing discharge from CSOs. The City will continue to improve the interceptor and CSO system efficiency through enhanced hydraulic modeling.

Remote Site Primary Treatment: Remote site primary treatment would result in concentrated wastewater diversion back to the interceptor and treatment plant, regardless of the specific technology used. This is because the screenings from fine screening, concentrate from a swirl concentrator, and sediment from sedimentation basins would need disposal as a regular operation procedure. The most likely facility for receiving this waste is the existing wastewater treatment plant. The actual expense per gallon of treating the concentrated wastewater would be somewhat higher than that incurred for storm water, due to greater concentrations of solids, nutrients, and other wastewater components. As with storage alternatives, this would increase the average wastewater flow, but to a lesser extent because much of the volume would not go to the plant.

Separation: Separation in conjunction with partial or total elimination of CSOs would impact the treatment plant less than CSO elimination alone. Total separation and aggressive rain-dependant inflow and infiltration abatement would be the only option to completely avoid impact to the wastewater treatment plant, since no storm water would be received in the interceptor. It may be possible to use separation as part of an integrated approach to CSO reduction in combination with regulator adjustment or best management practices. This would reduce the hydraulic and treatment impact to the treatment plant and reduce the water quality impact to receiving waters.

Direct storm water discharge may need to be treated in the future, which might negate any advantage to separation. At this time, EPA is in the process of evaluating the water quality impacts of storm water discharges as part of the Clean Water Act (CWA) mandate for NPDES storm water permitting. Separation coupled with retention and treatment facilities discharging to the ground would mitigate this concern.

Increasing Interceptor Capacity: This would have the most direct impact on the treatment plant's available capacity. The current interceptor capacity matches the treatment plant's hydraulic capacity at the headworks. An increase in interceptor capacity to take all remaining CSO flows for a 1-year storm would require an increased storm water capacity at the headworks and either more storm water storage capacity or additional primary treatment separate from the existing treatment trains.

6.2.1 Water Quality Effect at High Flows

At high flows, Latah Creek is the primary source of pollutant loads for the Spokane River above the advanced wastewater treatment plant. Latah Creek carries relatively high sediment and nutrient loads during spring runoff (Soltero et al, 1990). The pollutant

loads from the SAWTP to the Spokane River during high river flow periods are relatively small. For example, as shown in Table 6-1 the average TP concentration in Latah Creek during a storm event and high river flow is more than five times the concentration in the Spokane River immediately above Latah Creek. For the sampled events, Latah Creek had an average load of about 26 pounds per day. The average event TP load from SAWTP CSO discharges during high river flow is 7.8 pounds, occurring 13 times over the past 3 years (City of Spokane Advanced Wastewater Treatment Plant data, 1993).

6.2.2 Water Quality Effect at Low Flows

At low flows, the water quality of the Spokane River and Long Lake is primarily influenced by the sediment and nutrient loads discharged from the SAWTP during wet weather. A wet weather event during low flows with the existing CSO flow rate can affect water quality parameters in the Spokane River to the extent that they fall below Class 'A' standards as set forth in WAC 173-203 (Soltero et al, 1990; Ecology, 1991). Table 6-1 shows the concentrations of selected water quality parameters in the Spokane River during low flow storm events.

Increasing primary-treated storm-event flows through the treatment plant could increase the negative impact of the plant's discharges during wet weather discharges at low river flow rates. Additional flow from timed release out of a storage facility that would be treated to advanced standards and comply with the requirements currently imposed on the SAWTP discharges would have less of a negative water quality impact. However, advanced treated discharge has a considerably higher cost per gallon than primary-treated discharge.

TABLE 6-1. SPOKANE RIVER WATER QUALITY DURING STORM EVENTS[1]

	Dissolved Oxygen (mg/l)		Nitrate as Nitrogen (mg/l)		Total Phosphorus (mg/l)[2]		Total Suspended Solids (mg/l)		Fecal Coliform (lb/m)[3]	
	Flow in River		Flow in River		Flow in River		Flow in River		Flow in River	
	High	Low	High	Low	High	Low	High	Low	High	Low
Water Works	9.8	7.7	0.28	0.565	0.007	0.0265	2	2.5	25	75
Green Street Bridge	10	7.55	0.14	0.535	0.009	0.020	3.5	2	28.5	445
Mission Ave. Bridge	10	7.65	0.15	0.52	0.0115	0.0215	2	2	52.5	795
Trent Ave. Bridge	10	7.7	0.135	0.49	0.009	0.023	3	2	70.5	450
Division St. Bridge	9.95	8.1	0.135	0.505	0.0215	0.021	2	2	305.5	550
Maple Bridge	10.9	9.35	0.155	0.5	0.0145	0.0255	2	2.5	650	3,050
Old High Bridge Rail Crossing	11.4	0	0.195	0.57	0.012	0.0315	2	2.5	280	2,300
Latah Creek	9.3	7.7	0.335	0.98	0.070	0.2255	11	40	385	28,000
T.J. Meenach Bridge	11.05	8.9	0.175	0.605	0.014	0.034	2.5	3	420	15,250
SAWTP Data	8.5	7.8	N/A	N/A	0.470	0.430	4.5	7.5	6	20

1. Average parameters in the Spokane River for two events during high flow in Spokane River in May 1990 (average at USGS gauging station = 11,348 cfs) and for two events during low flow in Spokane River in July and August 1990 (average at USGS gauging station = 2,004 cfs). From Eastern Washington University (EWU) data.
2. mg/l = milligrams per liter
3. lb/m = pounds per month
4. From Spokane Advanced Water Treatment Plant records for May, July, and August 1990, corresponding with EWU sampling dates.

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6.3 CONSTRUCTION AND OPERATIONS AND MAINTENANCE COSTS

Direct capital improvement costs and O&M costs are calculated for technologies highlighted in Chapter 5, which are fully developed into alternatives discussed in Chapter 7. Specifically, the items associated with each major technology are shown below.

- Best Management Practices: street cleaning; interceptor system flushing; catch basin cleaning; sewer rehabilitation with inflow and infiltration reduction; on-site retention swales as a BMP, including curb modification, excavation, and sprinkler systems; city ordinances, including those requiring on-site detention storage, using flow control devices and/or specially constructed detention basins, either as part of a park or structure or as enclosed storage, and treatment costs.

- Optimization: through regulator modification, reducing CSO to the one event per year goal, including labor costs for replacing or re-positioning leaping weirs, material costs for replacement or repairs, treatment costs, and engineering costs.

- Storage: including property or right-of-way acquisition; the least cost construction among on-site detention, in-line and off-line storage, any of which may be pipe packages or tanks; storage in existing lines; control structures; increased treatment plant costs and operations and maintenance costs.

- Remote-Site Primary Treatment: including property acquisition, site preparation, equipment purchase and installation, engineering costs, and operation and maintenance costs, including treatment and disinfection at SAWTP of concentrated effluent from the remote-site facility.

- Separation: including engineering and construction costs for all new storm (or sanitary) sewers, and maintenance costs.

- Increased Interceptor and Treatment Plant Capacity: costs for repair or replacement. For the treatment plant, includes per-gallon treatment cost projections based on new costs to meet new NPDES requirements including chlorination and dechlorination of primary-treated storm water.

As each basin tributary to a CSO regulator is assessed to determine the effectiveness of the identified control/treatment strategies, it may become apparent that more than one strategy is appropriate for a specific regulator.

The EPA produced a document in 1978 entitled, *Cost Methodology for Control of Combined Sewer Overflow and Storm Water Discharge*. Construction and O&M costs were calculated using formulas in this document and then compared with recent projects constructed in the United States and Canada.

Recent City of Spokane costs for the construction of storage tanks, interceptors, and sewers were used in estimating costs. Maintenance costs are calculated by estimating the required staff hours needed for maintenance and applying the City's rate per staff hour plus equipment and other costs.

Costs were all converted into 1992 dollars using the Engineering News Record Construction Cost Index (ENR CCI). Since all costs were converted to 1992 dollars, inflation was not taken into account. When calculating present value, a 7 percent interest rate with a 20-year term was assumed. Examples of direct capital improvement costs for the considered technologies are shown in Table 6-2. Examples of O&M costs for the considered technologies are shown in Table 6-3. For the specific data and calculations used in cost estimating see Appendix M.

It is anticipated that due to the wide range of actions and the complexity of the CSO basins tributary to each regulator, that this Plan will provide an overall approach to reduction of CSOs to the Spokane River. Because of this, costs for these actions should be considered preliminary in nature.

6.4 ECONOMIC CAPABILITY OF MUNICIPALITY

The economic capability of a municipality depends on the economic health of the City and the political climate. Table 6-4 shows how the real estate market has changed in the last 10 years. The number of building permits and the number and price of home and land sales are tending upward. Spokane is a growing city with a population that looks closely at additional public expenditures. Public money for non-growth related projects is less available as essential municipal services are extended to areas of rapid growth.

TABLE 6-2. DIRECT CAPITAL IMPROVEMENT COSTS INCURRED IN OTHER CSO REDUCTION PROJECTS

CSO Reduction Project	Location	Units	Quantity	Unit Cost (1992) ($1,000)	Capital Cost (1992) ($1,000)	Average Per Capita Income (1990) ($1,000)
Storage	Seattle, WA	MG[1]	11.1	3,580	39,916	46
Off-Line Storage	Worcester, MA	MG	3.0	163	490	42
Off-Line Storage	Toronto, Ont.	MG	1.0	178	178	N/A
Off-Line Storage	Kingston, Ont.	MG	1.3	197	256	N/A
Off-Line Storage	Saginaw, MI	MG	2.0	42	84	31
Off-Line Storage	Hamilton, Ont.	MG	5.5	30	165	N/A
Off-Line Storage	Detroit, MI	MG	5.7	48	272	40
Off-Line Storage	Saginaw, MI	MG	4.6	70	322	31
Separation	Seattle, WA	acres	821.0	35	29,049	46
Separation	Spokane, WA	acres	640.0	6	4,008	30
Separation	Spokane, WA	acres	320.0	9	2,774	30
Primary Treatment	Oakland, CA	mgd[2]	158.0	133	21,000	49
Primary Treatment	Toronto, Ont.	mgd	308.0	58	17,800	N/A

1. MG = million gallons.
2. mgd = million gallons per day.

TABLE 6-3. OPERATION AND MAINTENANCE COSTS INCURRED IN OTHER CSO REDUCTION PROJECTS

CSO Reduction Project	Location	Units	Quantity	Unit Maintenance Cost (1992) ($1,000)	Annual Operation and Maintenance Cost (1992) ($1,000)
Storage	Seattle, WA	MG[1]	11.1	18.7	208.1
Off-Line Storage	Worcester, MA	MG	3.0	26.7	80.0
Off-Line Storage	Toronto, Ont.	MG	1.0	40.0	40.0
Off-Line Storage	Kingston, Ont.	MG	1.3	34.6	45.0
Off-Line Storage	Saginaw, MI	MG	2.0	2.50	5.0
Off-Line Storage	Hamilton, Ont.	MG	5.5	2.73	15.0
Off-Line Storage	Detroit, MI	MG	5.7	14.0	80.0
Off-Line Storage	Saginaw, MI	MG	4.6	26.1	120.0
Separation	Seattle, WA	acres	821.0	0.129	94.5
Separation	Spokane, WA	acres	640.0	0.05	30.5
Separation	Spokane, WA	acres	320.0	0.05	15.2
Primary Treatment	Oakland, CA	mgd[2]	158.0	0.30	47.4
Primary Treatment	Toronto, Ont.	mgd	308.0	0.21	63.0

1. MG = million gallons.
2. mgd = million gallons per day.

TABLE 6-4. REAL ESTATE SALES AND BUILDING PERMITS

Year	City of Spokane Land Number	City of Spokane Land Average Price ($)	City of Spokane Residences Number	City of Spokane Residences Average Price ($)	Residential Building Permits City of Spokane (Units)
1980	157	1,860	3,030	41,396	542
1981	89	12,061	2,394	43,821	754
1982	116	12,717	1,865	43,948	306
1983	201	14,644	2,583	43,881	425
1984	194	15,747	2,833	44,728	833
1985	210	17,474	2,766	46,531	907
1986	219	15,943	2,804	48,381	640
1987	160	21,121	2,269	49,058	516
1988	136	18,395	2,331	49,137	330
1989	184	19,207	2,728	51,224	718
1990	449	34,574	5,158	55,760	812
1991	512	27,813	5,158	62,003	765

Source: City of Spokane Public Works Department

The revenue for wastewater projects comes from ratepayers, either through direct payment of wastewater rates or through taxes which come back to the City in the form of state government grants. Historically, rates have increased about five percent a year, as shown in Table 6-5. Currently, the proportion of residential wastewater rates allocated for debt service for CSO reduction is 29 percent (1992 rates). The board which approves rate hikes has indicated that it will not approve rate hikes appreciably above this amount. Therefore, the only way to increase revenue above cost-of-living increases is to add new customers. Treating CSO discharge uses wastewater plant capacity which could be sold to ratepayers. Lost revenue has to be considered very seriously when proposing to treat CSO discharge at the wastewater treatment plant.

The City of Spokane has had a number of recent and concurrent expenditures for improving water quality. From 1980 through 1990 the City spent $50 million (in 1992 dollars) on engineering and construction of CSO reduction projects alone. The City will soon be undertaking a Storm Water Management Plan, which may indicate further significant capital improvement expenditures to comply with storm water NPDES permit requirements. Table 6-6 lists the expected water quality-associated expenditures for 1992-1998. Details of the expected expenditures can be found in Appendix D, *Six-Year Comprehensive Sewer Program*. Of particular importance to this study is that the City has budgeted to spend $800,000 on CSO reduction during that period, including $440,000 for construction and construction management. The average annual expenditure used to estimate the CSO reduction project schedule is $1 million per year, which is consistent with City budget projections.

As well as water quality expenditures, the City is now servicing debt on the recent Spokane Waste-to-Energy project, a new main public library, and two major bridge construction projects. Expenditures expected in the near future include two additional bridge construction projects, compliance with particulate and carbon-monoxide air pollution restrictions, and compliance with the Safe Drinking Water Act, which may include significant expenditures.

In deciding how to spend money most effectively on water quality projects, the City must evaluate how money can best be used to improve or maintain water quality in the Spokane River. This is important since the Spokane River exchanges water with the Spokane-Rathdrum Aquifer, the region's only source of drinking water.

TABLE 6-5. CITY OF SPOKANE MONTHLY WASTEWATER BILLING*

Billing Category	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
In City											
Residential	13.10	12.56	11.79	10.55	9.75	8.85	8.50	7.68	7.11	6.71	6.33
Apartment after 1st	12.60	12.06	11.29	10.55	9.25	8.35	8.00	6.68	6.11	5.71	5.33
Commercial											
Base Rate	9.34	9.07	8.48	7.45	6.65	6.19	5.85	5.18	4.42	3.77	3.56
per 100 cu. ft.	0.5911	0.5640	0.5250	0.4654	0.4270	0.3795	0.3638	0.3300	0.3300	0.3600	0.3400
Outside City											
Residential	16.09	15.35	14.54	13.00	12.00	8.85	8.50	7.68	7.11	6.71	6.33
Apartment after 1st	15.59	14.85	14.04	12.50	11.50	8.35	8.00	6.68	6.11	5.71	5.33
Commercial											
Base Rate	9.34	9.07	8.48	7.45	6.65	6.19	5.85	5.18	4.42	3.77	3.56
per 100 cu. ft	0.8300	0.7890	0.7100	0.6235	0.5592	0.3795	0.3638	0.3300	0.3300	0.3600	0.3400
Household Debt Service											
On CSO Projects	3.78	3.78	3.78	3.78	1.64	1.64	1.64				

* City of Spokane Wastewater Treatment Plant

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TABLE 6-6. CITY OF SPOKANE
WATER QUALITY PROJECTS
SIX-YEAR PROGRAM FINANCIAL SUMMARY
(In thousands of dollars)

OPERATION AND MAINTENANCE							
	1992	1993	1994	1995	1996	1997	1998
Sewer Service Revenue	16,536	16,553	17,383	18,108	18,867	19,641	20,436
Other Operational Revenue	3,500	2,714	1,275	1,271	1,139	1,046	991
TOTAL REVENUES	20,037	19,267	18,658	19,379	20,006	20,687	21,427
O&M EXPENSES	16,372	16,020	16,822	17,257	17,835	18,487	19,162
CAPITAL							
Six-Year Capital Program							
Rehabilitation Program	350	450	500	600	600	600	600
Septic Tank Elimination Program - Aquifer Protection Fund Support	1,021	0	180	105	283	115	0
Capital Improvement Program							
Wastewater Collection	6,741	747	427	1,969	655	243	253
Storm Water Management	382	806	860	200	300	300	300
Treatment Plant	273	1,361	2,043	3,854	8,624	8,758	1,947
TOTAL PROGRAM EXPENSES:	8,767	3,364	4,011	6,728	10,462	10,017	3,100
Fund Balance & Adjustments							
Capital Balance less Program Expenses	2,038	2,746	3,007	2,730	2,061	512	2,345
Proposed Rate Adjustment		5.00%	4.00%	4.00%	4.00%	4.00%	4.00%
Revenue from Rate Adjustment	0	798	695	724	754	785	817
CAPITAL FUND BALANCE	2,038	3,544	3,702	3,454	2,816	1,298	3,162

1. Capital Fund balances do not include emergency reserves or operations funds.
2. Emergency Reserves balance as of 1/1/92 was $1,668,000.
3. Amounts may not add as shown due to rounding.
4. Monies for projects financed by the Local Improvement District are not shown in this table.

The City is in the process of preparing a Facility Plan for the advanced wastewater treatment plant. The plant is 15 years old and preliminary indications are that some systems may need updating at this time. The plant must be maintained to prevent water quality deterioration in the Spokane River. On an annual basis, pollutant and nutrient loading from CSO discharge is small compared to the total pollutant and nutrient load in the Spokane River. The City's goal is to meet the CSO regulations but not to the point of letting river water quality deteriorate due to lack of money to maintain the treatment plant.

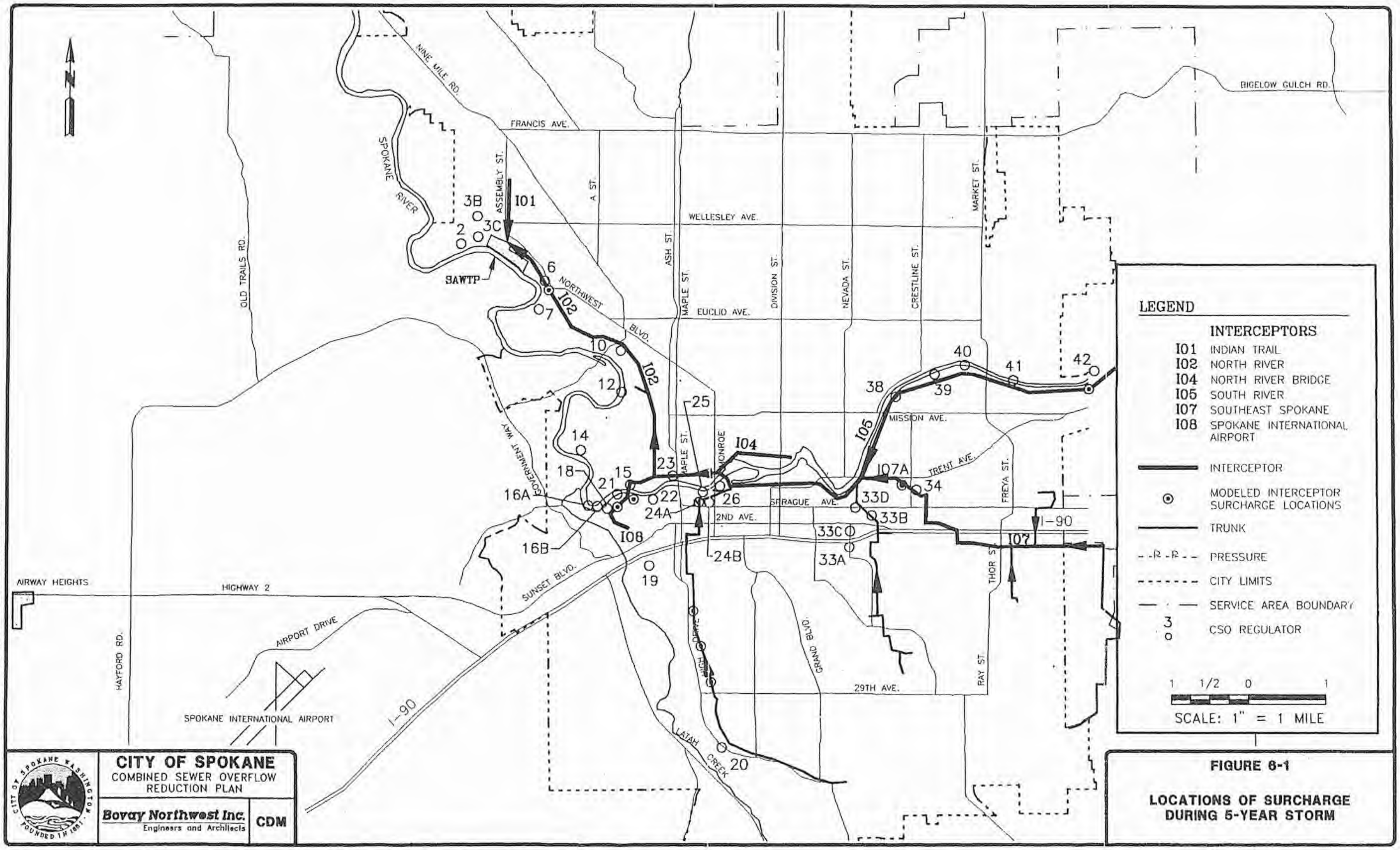
6.5 SURCHARGE OF INTERCEPTOR AND INTERCEPTOR CAPACITY

All alternatives were evaluated against the probability of interceptor surcharge. Interceptor surcharge for the purpose of analysis is defined as the point at which the interceptor pipe in question is flowing full. This definition was chosen instead of a pressure conduit flow definition to protect the integrity of pipe joints in older pipe that might not withstand pressure flow conditions. This would be done to maximize the theoretical capacity of the interceptor system. Flow monitoring indicates that some portions of the interceptor system already surcharge during a 5-year storm event. The locations are shown in Figure 6-1.

The most frequent existing surcharge locations are on the South River Interceptor along the Spokane River upstream of Spokane Community College. Existing surcharging pipes would be relieved or replaced under an optimally managed alternative. Surcharge damage can diminish the effectiveness of the wastewater collection and interception system. Surcharging may cause backup of wastewater into trunks, collectors and service connections. Planned surcharge is also undesirable since it eliminates the factor of safety designed into the system for carrying peak flows.

To be effective, storage control alternatives presume the pre-surcharge capacity of the system is being maximized in order to minimize storage.

Full and partial separation options reduce overall storm flows into the system and by definition contribute to a lessening of surcharge pressure, frequency, or both. The proposed project costs include the cost of increasing interceptor capacity to avoid surcharge.



LEGEND
INTERCEPTORS
I01 INDIAN TRAIL
I02 NORTH RIVER
I04 NORTH RIVER BRIDGE
I05 SOUTH RIVER
I07 SOUTHEAST SPOKANE
I08 SPOKANE INTERNATIONAL AIRPORT
INTERCEPTOR
MODELED INTERCEPTOR SURCHARGE LOCATIONS
TRUNK
PRESSURE
CITY LIMITS
SERVICE AREA BOUNDARY
CSO REGULATOR
SCALE: 1" = 1 MILE
CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN
Bovay Northwest Inc. Engineers and Architects
CDM
FIGURE 6-1
LOCATIONS OF SURCHARGE DURING 5-YEAR STORM

6.6 OPERATIONAL IMPACTS DUE TO ADDED COMPLEXITY

Operational aspects of the alternatives that are significantly different from the existing wastewater system are reflected in the cost of operations.

Best management practice alternatives such as street cleaning, catch basin cleaning, and on-site retention primarily incur additional operation expenses and do not involve added operating complexities, though new technology may add operations complexity. Other BMPs include institutional controls that do not have associated technical operations complexity, but may have added administrative complexity due to new regulations.

Storage and treatment alternatives carry operational burdens which may relate to pumping, cleaning, odor control, chemical addition, security, and landscaping at some sites. Storage controls which utilize enlarged sewer pipes (in-line storage) may require less operational complexity than large off-line vaults installed with primary treatment. However, general storage at this time is more operationally complex than sewer system separation or increased capacity with continued treatment only at the SAWTP.

Separation oriented alternatives are capital intensive programs with normal sewer system maintenance for both storm and sanitary sewers. Future monitoring costs can be expected to be incurred for storm water discharges to aid in meeting water quality requirements.

6.7 FUTURE REGULATIONS

Water quality control regulations have become increasingly more stringent. Combined sewer overflow regulation has been a major regulatory emphasis in the City of Spokane since the Federal Water Pollution Control Act Amendments of 1972. Until that time, combined sewer overflows were tolerated and their control was not a high priority in the regulatory agency grant programs (Water Pollution Control Federation, 1989). However, since the early 1970's, CSO control technologies have advanced and CSO controls have become more regimented and are now based on a discharge frequency approach (the current one CSO event per year per outfall). This approach is relatively easy to administer but offers municipalities less flexibility. As an example, transfer of a CSO discharge from a sensitive recreational area to allow discharge at a depth in a less sensitive reach of river is not possible under the current administrative approach, since this would only transfer the CSO rather than control it. Sensitivity of water bodies to water depth and dispersion of discharge are not in the present regulatory approach except in ranking control actions in the implementation schedule for a permit.

From a strict water quality standpoint, CSO discharges piped to less sensitive reaches of a water body would have a lesser water quality impact. For example, if CSOs are discharged in highly turbulent river reaches, natural aeration will decrease the oxygen demand loads and induce nitrification in the river. Phosphorus concentrations would not be affected, however.

Best management practices, particularly source control BMPs, will probably continue to be in line with future regulations. This is because source controls such as retention swales with upstream sediment traps and oil/water separators limit the flow of wastewater to the collection system and minimize the potential for storm water to become mixed with pollutants. City ordinances directed at source control will most likely remain in line as well, since wastewater reduction has historically been a cost-effective means to reduce impacts to treatment facilities and receiving waters.

Storage facilities to reduce peak flows to more evenly utilize existing treatment capacity should continue to be a strategy to address future regulations. In combination with treatment, storage could be used to meet future requirements for CSO discharge quantity and/or quality.

With current CSO regulation in the State of Washington, remote-site treatment alternatives may be viewed favorably because of the standard of treating CSO wastewater to remove only 50 percent of TSS prior to discharge. However, the current regulations also state that the "total treated and untreated CSO discharge from an at-site [remote-site] treatment plant shall not increase above the baseline annual" (WAC 173-245, 1987). River water quality standards may have to be met inside a standard mixing zone using no more than 25 percent of river width and extending less than 300 feet downriver. This could force much more stringent end-of-pipe treatment requirements for the large CSO discharges for which it would be most economical to install a remote-site treatment facility.

Future regulations may make separation and direct discharge of storm water more expensive than other alternatives. As a result, separation may be a viable alternative only in combination with several other control alternatives, such as discharging to a retention swale following oil/water separation and sediment control measures.

More stringent requirements for the advanced wastewater treatment plant discharge may make increasing interceptor and treatment plant capacity more expensive than present projections.

There has been a tightening of the regulatory guidelines and criteria for specific pollutants as more scientific data is gathered and as analytical measurement techniques become more sophisticated. At this time there are no specific regulations covering the allowable water

quality of primary treated CSO discharges other than surface water quality standards. However, guidelines and criteria for treatment of specific pollutants in CSO are anticipated in the future.

More stringent regulations have to be anticipated both for combined sewer overflows and storm water because of new surface water quality standards. Combined sewer overflow impacts and public concerns over Spokane River water quality resulting from occasional CSO events are easier to demonstrate than the more subtle water quality impacts of storm water.

Concurrently storm water discharges have become subject to permit, as the recent NPDES storm water discharge permit process attests. This is partially a result of the 1983 NURP results in cities such as Bellevue, Washington and the subsequent amendment to the Federal Water Pollution Control Act in 1987, Section 405 (Koch, 1993). Concerns about storm water impacts may increase as CSOs are controlled, either due to separation or because of a shift in regulatory priorities. This may make it more cost-efficient to treat CSO only rather than to separate and treat both limited CSO and a large number of storm water discharges.

6.8 PRACTICALITY AND BENEFITS OF PHASED AND INTEGRATED IMPLEMENTATION

The recommended schedule for implementation, detailed in Chapter 8, recommends phased and integrated implementation. Use of source control and existing system management would be implemented and subsequently evaluated before more costly storage or treatment projects are constructed.

Integrated implementation means that individual basins may utilize more than one control/treatment alternative to reduce CSO, and that CSO reduction will be approached on both a basin-by-basin and system-wide basis. BMPs are best implemented on a basin-by-basin basis, and the capital construction projects considered in this Plan are more cost-effective on a system-wide basis. To achieve the most reasonable and cost-efficient reduction of CSO, more than one treatment control alternative may be utilized. To ensure the effectiveness of this approach, sufficient planning must be done within a given basin to design projects to be compatible. The same integration to ensure project compatibility must be accomplished throughout the combined sewer system, integrating City-wide BMPs such as source control ordinances, infiltration and inflow reduction, and on-site retention with the sizing of any required storage and treatment.

6.9 COMPLIANCE WITH THE SEPA

The SEPA, enacted in 1971, has provisions with which all selected alternatives must comply. Washington's SEPA, Chapter 43.21C, RCW, requires all state and local governmental agencies to "consider environmental values ... for their own actions ..." (Council on Environmental Policy, 1976). This resulted in a checklist of environmental values to be filled for each capital project undertaken by or under the review of a state or local government entity. The checklist enables determination of whether or not an environmental impact statement is required for a proposed project.

This document is not specifically a SEPA environmental checklist. However, the proposed items on the project schedule will be evaluated by the City prior to engineering for all items on the standard SEPA environmental checklist, and a checklist will be submitted prior to design for construction of any control/treatment alternatives. If mitigation for a treatment/control alternative is required under the SEPA it may mean additional costs for that alternative.

7

7

BOVAY
NORTHWEST

CHAPTER 7. EVALUATION OF CONTROL TREATMENT ALTERNATIVES

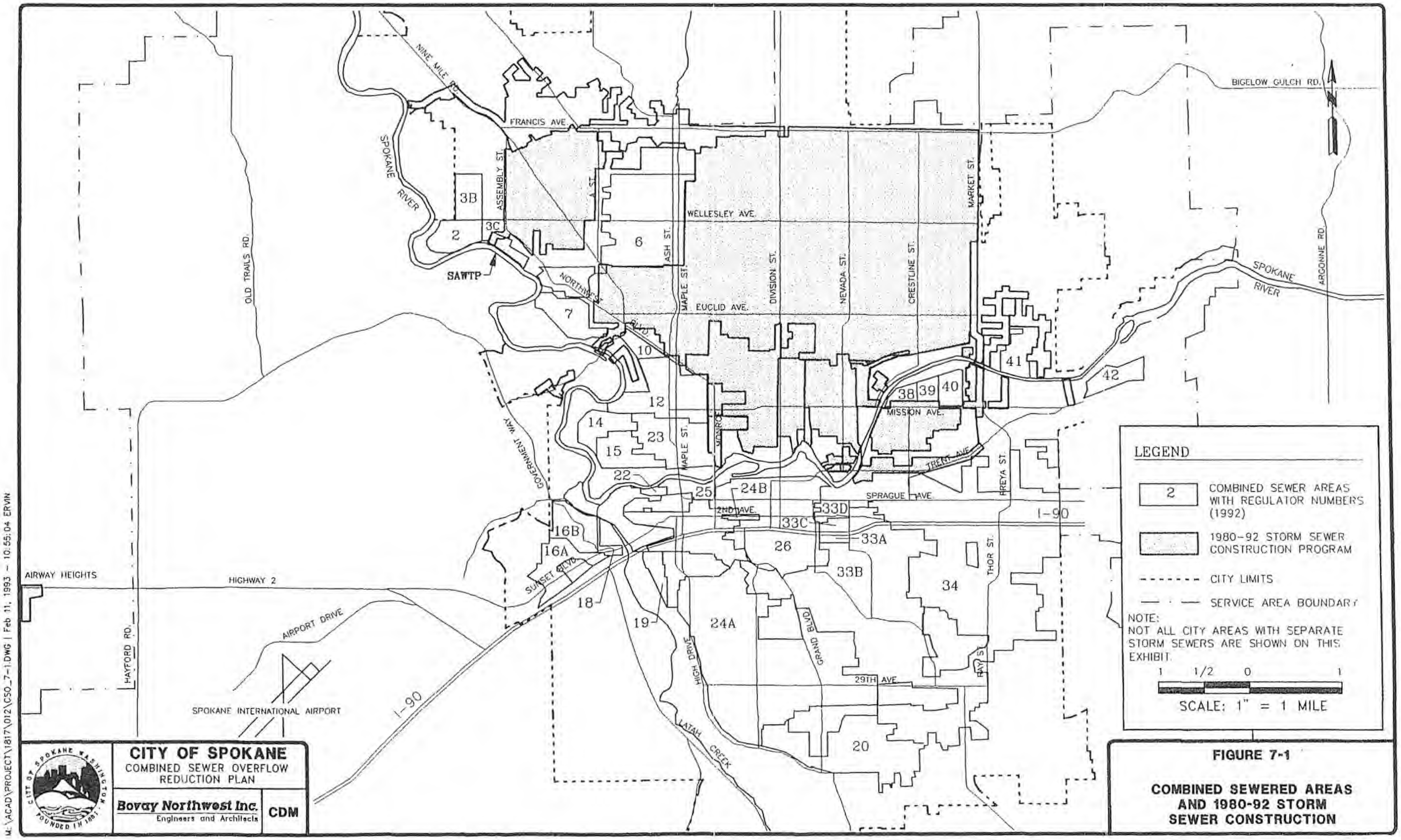
7.1 PURPOSE AND INTRODUCTION

The purpose of this Chapter is two-fold. First, this Chapter indicates which are the best alternatives available at this time for reduction of CSO in Spokane. Second, this Chapter is intended to be a guide for preparation of more detailed predesign reports, or basin plans, specific to individual CSO basins.

To use this Chapter as a guide for preparation of basin plans, the reader should first refer to the guidelines for basin plan preparation in Chapter 8. Information for project overviews and plot plans are given in this Chapter, including approximate locations of structures and some impervious surfaces, and descriptions and locations of pertinent existing basin features. The anticipated consequences of wastewater source reduction ordinances for specific land uses are also addressed.

The reader is referred to Table 3-3 for specific CSO basin land use information. Figure 7-1 shows the existing CSO basins. Figure 7-2 is a schematic representation of the wastewater collection system, including the major combined and separated sewer inputs to the interceptor. Table 7-1 is a listing of existing flows in the City collection system corresponding to the major inputs shown in Figure 7-2. Table 7-1 is formatted for comparison with similar tables throughout this Chapter that identify the projected flows resulting from CSO reduction strategies.

This Chapter is organized into CSO reduction strategies. A CSO reduction strategy option is an assembly of technologies that together meet the WAC 173-245 minimum criteria of reducing overflow to one event per year per outfall. Preliminary to implementing any strategy option using capital facilities, BMPs will be implemented that may have city-wide or basin-specific application. Best management practices implementation is the first strategy discussion in this Chapter. Thereafter, each CSO reduction strategy option addresses a combination of technologies that can be integrated with BMPs and phased as described in Chapter 6; each is applied to specific basins. The reader may refer to any CSO reduction strategy option and locate any CSO basin by numerical order within the selected strategy option. Documentation of the evaluation and analysis of the following CSO reduction strategy options is included.



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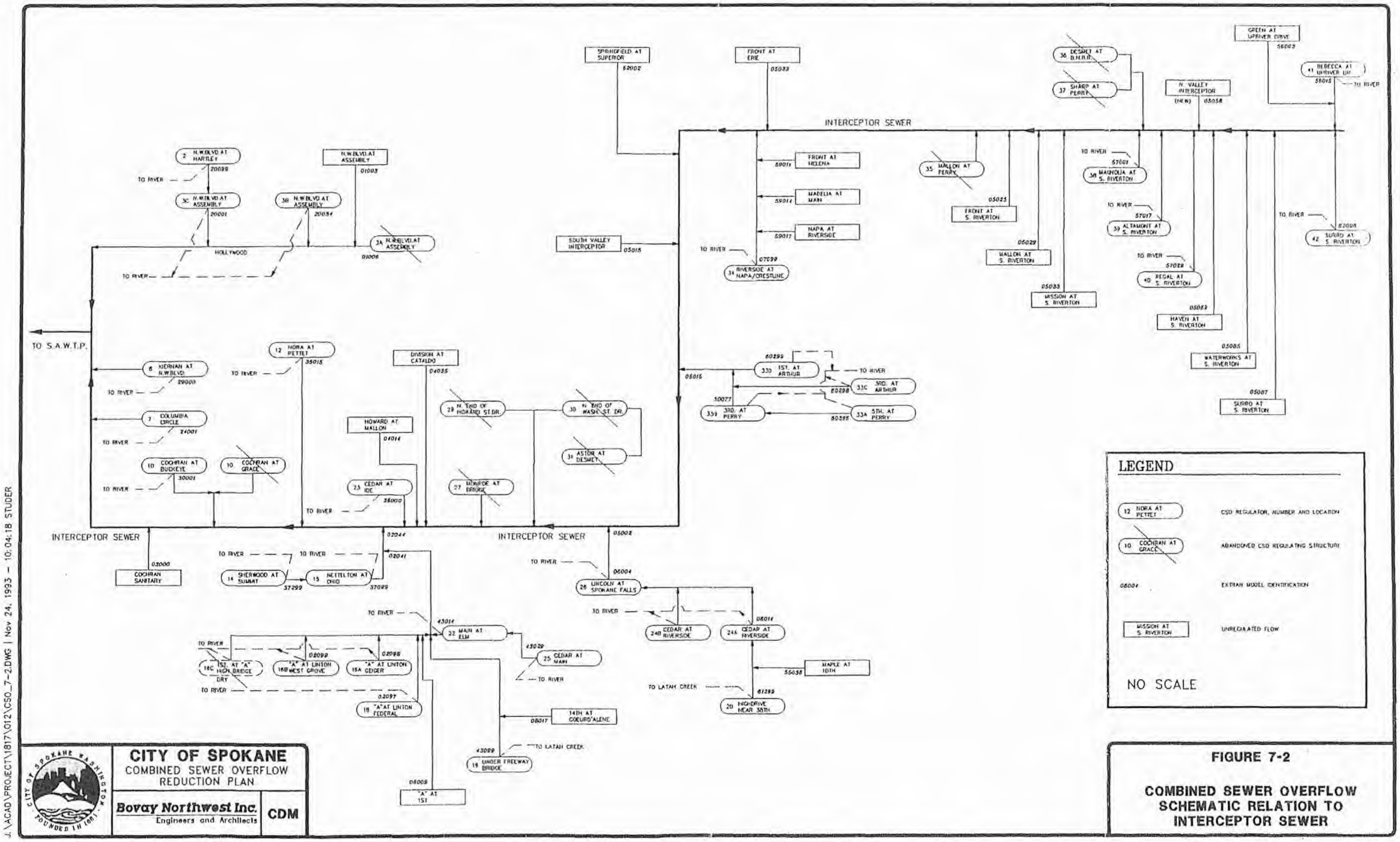

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TABLE 7–1. EXISTING SYSTEM, MODELING CHARACTERISTICS AND RESULTS

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1–YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Surro at S. Riverton	62006	42	0.33	10.89	0.31	7	2.00			2.0	2.0
Surro at S. Riverton	05087		0.11	0.19			0.19	2.0	2.0	2.1	2.5
Waterworks at S. Riverton	05085		0.17	0.32			0.32	2.1	2.5	2.0	1.2
Haven at S. Riverton	05059		0.26	0.45			0.45	2.0	3.7	3.9	12.2
North Valley Interceptor	05058		0.20	0.66			0.67	3.9	12.2	6.3	10.7
Rebecca at Upriver Dr.	56015	41	0.08	12.31	0.52	11	1.57			1.6	1.5
Green at Upriver Drive	56003		0.19	0.63			0.63	1.5	5.7	1.6	30.6
Regal at S. Riverton	57029	40	0.07	8.93	1.45	32	0.60			0.6	0.6
Altamont at S. Riverton	57017	39	0.03	5.15	1.06	34	0.28			0.3	0.3
Magnolia at S. Riverton	57001	38	0.09	5.81	0.28	10	0.69			0.7	0.7
Mission at S. Riverton	05033		0.15	0.51			0.51	7.2	16.2	10.7	16.7
Mallon at S. Riverton	05029		0.42	1.45			1.45	10.7	16.7	12.3	24.6
Front at S. Riverton	05025		0.21	0.38			0.38	12.3	24.6	14.7	25.1
Front at Erie	05023		0.17	0.69			0.69	14.7	25.1	15.5	24.7
Riverside at Napa/Crest.	07099	34	3.50	88.22	11.78	13	13.77			17.7	16.5
Napa at Riverside	59017		0.07	0.34			0.34	17.7	15.4	17.3	15.4
Madelia at Main	59014		0.08	3.33			4.22	17.3	15.4	16.9	15.4
Helena at Front	59011		0.36	11.73			14.75	16.9	15.4	17.2	15.8
Springfield at Superior	52002		0.29	0.98			0.98	7.2	16.2	10.7	16.7
South Valley Interceptor	05015		1.69	2.64			2.64	33.3	57.2	53.4	55.7
5th at Arthur	60396	33A	0.05	5.77	0.00	0	2.00			0.8	2.1
3rd at Perry	60077	33B	1.60	102.00	2.30	5	19.32	104.5	102.1	46.3	16.7
3rd at Arthur	60298	33C	0.05	2.78	0.12	11	0.45			0.3	0.5
1st at Arthur	60299	33D	0.25	14.08	2.03	42	0.76			0.8	0.8
Highdrive near 33rd	61299	20	0.19	35.67	0.11	2	6.52			6.8	6.5
Maple at 10th	55036		0.37	0.66			0.66	57.9	71.3	58.9	77.5
Cedar at Riverside	06014	24	3.30	54.17	2.12	3	12.20	58.8	77.7	68.0	118.7
Lincoln at Spokane Falls	06004	26	8.00	85.30	19.73	15	36.80	16.7	14.1	98.3	154.7
Division at Cataldo	04025		1.17	3.63			3.63			4.9	27.9
Howard at Mallon	04014		0.14	0.43			0.43	4.9	8.7	5.0	13.3

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TABLE 7-1. EXISTING SYSTEM, MODELING CHARACTERISTICS AND RESULTS (cont.)

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1-YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Cedar at Ide	36000	23	0.25	18.74	1.69	18	2.00			2.3	2.3
Sherwood at Summit	37299	14	0.10	5.65	0.86	17	0.80			0.8	0.8
Nettleton at Ohio	37099	15	0.33	20.56	4.47	34	1.97			2.9	3.1
Under Freeway Bridge[6]	43099	19	0.05	4.96	0.00	0	34.11			5.9	23.3
Coeur d'Alene at 14th	08017		0.84	2.18			2.18	5.9	44.8	9.1	28.6
Cedar at Main	43029	25	0.12	4.76	0.35	19	0.59			0.3	0.6
Main at Elm St.	43014	22	0.16	3.75	0.00	0	2.20	0.3	0.6	1.2	2.1
"A" Street at Linton	02099	16B	0.26	9.59	0.50	12	1.27			2.5	2.9
"A" Street at Linton	02098	16A	0.24	3.95	0.01	0	2.90			2.5	3.0
1st at A street	02097	18	0.08	1.00	0.00	1	0.25			-0.3	0.3
"A" at 1st	08009		0.15	0.40			0.40	9.0	28.4	9.1	29.8
Nora at Pettet	35015	12	0.70	51.33	9.65	35	3.80			3.9	3.7
Cochran at Buckeye	30001	10	0.09	7.17	0.27	7	1.06			0.8	1.0
Cochran Sanitary	03000		6.68	31.33			31.33			133.5	117.6
Columbia Circle	24001	7	0.14	14.27	0.81	13	2.07			2.2	2.1
Kiernan at NW Blvd	29000	6	0.64	52.60	14.12	34	2.94			3.2	3.0
NW Blvd. at Hartley	20099	2	0.05	4.45	1.72	40	0.30			0.3	0.3
NW Blvd. at Assembly	20001	3C	0.07	2.11	1.94	51	0.47	0.3	7.2	2.8	7.1
NW Blvd. at Assembly	20034	3B	0.04	0.93	0.00	1	0.22			0.2	0.4
N.W. Blvd. at Assembly	01006		3.56	3.02			3.02	0.2	25.8	7.3	29.7
N.W. Blvd. at Assembly	01003		0.13	0.11			0.11	7.3	17.8	7.4	22.1
SAWTP[7]			32.60	95.57			128.17	128.6	125.2	128.6	146.0

1. BWWF = Base Wastewater Flow.
2. For unregulated flow, maximum intercepted flow shown is the 5-yr storm flow.
3. One-year storm flows include average base wastewater flows.
4. mgd = million gallons per day.
5. MG = million gallons.
6. Maximum intercepted flow is the 50-yr storm flow.
7. 1990 dry weather SAWTP flow, estimated from the sum of input flows, is 33.99 mgd.

- Best management practices, including street cleaning, catch basin cleaning, public education programs, inflow and infiltration reduction, city ordinance revisions addressing source reduction and runoff control, and on-site retention swales; this strategy also integrates CSO regulator replacement, on-site detention storage and limited separation as reduction solutions

- Optimization and storage strategy option, including limited interceptor and treatment plant capacity increases, increasing flow from selected CSO regulators, and off-line storage and control

- Remote-site primary treatment strategy option, including storage and the least-cost primary treatment method currently available

- Separation strategy option, including separation of remaining CSO basins

- Increased interceptor primary capacity strategy option, including expanding capacity at SAWTP to treat remaining CSO discharge.

The strategy options were evaluated using computer models to simulate the hydraulic aspects of the wastewater system in the year 2010. It is assumed that improvements recommended in the Draft *Wastewater Facilities Planning Study* (Bovay, 1991) and the *Six-Year Comprehensive Sewer Program* (City of Spokane, 1992) will be in place by 2010. This Plan assumes that additional combined sewer will not be constructed. Additional flow in 2010 will be the result of projected land use changes and additional areas with sewer service. Another major assumption is that the one event per year criteria at the outfall can be met by restricting overflow at each regulator upstream of the outfall to one event per year. This assumption is reasonable because on the average, overflow resulting from a 1-year storm (as conservatively defined in Chapter 4) will be the threshold cause of overflow at regulators in adjacent basins that share the same outfall. This is predicated on regulators being previously adjusted to the one overflow per year setting.

The basis for the cost analysis is in Appendix M and the detailed descriptions and evaluations of the alternatives are in Appendix N. All capital costs are in 1992 dollars. For comparison, the 1992 present worth of operation and maintenance costs for the next 20 years was calculated using a 4 percent inflation rate and a 7 percent rate of return, based on the approximate City bond rate. The cost per annual volume reduction in dollars per million gallons for all the alternatives are shown in tables accompanying each section in Chapter 7. References are made throughout the chapter to high, moderate and low cost per gallon of CSO volume reduction. "High" cost refers to projects or alternatives that would cost over 60 cents per gallon of CSO volume reduction.

"Moderate" cost refers to projects or alternatives that would cost between 20 and 60 cents per gallon of CSO volume reduction; "low" cost projects and alternatives are below 20 cents per gallon of CSO volume reduction.

The reader is referred to Table 7-16 regarding the preliminary project selection for each CSO. It is anticipated that due to the wide range of actions and the complexity of the CSO basins tributary to each regulator, this Plan will provide an overall approach to reduction of CSOs to the Spokane River and Latah Creek. Because of this complexity, actual CSO reduction strategy implementation in basins will depend on more detailed analysis in specific basins.

7.2 BEST MANAGEMENT PRACTICE STRATEGIES

The beginning of this section outlines proposed actions that address city-wide combined sewer flows. The second portion of this section lists each basin, outlining the possible best management practices for each basin followed by the proposed actions resulting from the analysis and evaluation.

The city-wide best management practices considered in this section are street cleaning, catch-basin cleaning, water use reduction, public education programs, I/I reduction, and City drainage ordinance revisions. An integrated approach to CSO reduction including on-site retention strategies using grassed swale retention areas with dry well overflow capacity is considered for each basin. Separation and on-site detention storage integrated with best management practices are also considered for selected basins.

7.2.1 City-Wide CSO Reduction Best Management Practices

The City of Spokane has several strategies available to it for City-wide flow and CSO reduction. These strategies can be enacted by City ordinances or implemented as operational policy by the appropriate City agency. The impact of these strategies on individual CSO basins will be addressed in CSO basin plans. **None of the recommended projects in this Plan will be implemented prior to completion of the appropriate Basin Plans.**

Street Cleaning: Street cleaning does not directly reduce CSO volume. Under some circumstances street cleaning can reduce pollutant loadings. The study conducted in Austin, Texas, and cited in Chapter 5 documented water quality improvements in storm water runoff. This alternative may be used in conjunction with other alternatives to reduce treatment requirements at SAWTP or remote site treatment facilities. Further

study is required in Spokane to assess the effectiveness of increased street cleaning frequency on a city-wide or basin-specific basis.

Issues to consider when planning a street cleaning program to enhance run-off water quality include the use of advanced vacuum-type cleaning machines, the optimal times and frequencies for cleaning specific streets, and the cost per unit area. The cost per cleaning effort for each CSO basin has been calculated and is included in Table 7-2 for later use in basin plan preparation. The existing street cleaning program should continue, as it is not detrimental to CSO water quality and provides benefits outside the scope of this assessment.

Catch Basin Cleaning: Catch basin cleaning is most useful as a means to enhance the sediment trapping efficiency of catch basins. The *Puget Sound Stormwater Management Manual* calls for catch basin cleaning if the depth of deposits are equal to or greater than one-third of the depth from the basin (at the bottom) to the invert of the lowest pipe into or out of the basin. Since catch basin cleaning also includes grate cleaning, peak flows to the combined sewer system might actually increase while street ponding is reduced. The effect of catch basin cleaning on individual basins will be assessed in CSO basin plans. Catch basin cleaning should be coordinated with street cleaning to maximize catch basin cleaning efficiency.

Water Use Reduction: Wastewater flow is directly related to water usage. Water use reduction techniques that were evaluated for their effectiveness in Spokane include residential and commercial low flush volume toilet retrofits, and replacing shower heads with reduced-flow models. The costs and total volume reduction benefits for Spokane are shown in Table 7-3.

Water use reduction affects sanitary wastewater flow, a relatively small component of peak storm flows in combined sewers. Preliminary modeling results indicate that water use reduction will not significantly reduce CSO volume or frequency. Water use reduction would reduce average flows to SAWTP, possibly reducing operating costs at the plant. The most effective base wastewater flow reduction methods, building code enforcement, commercial toilet retrofit, high efficiency shower head retrofit and regional domestic toilet retrofit could cost as much as $24 million dollars. Building code enforcement and commercial toilet retrofit can be seen in Table 7-3 as the lowest cost, most effective flow reduction alternatives.

TABLE 7-2. ANNUAL STREET CLEANING COSTS BY BASIN

CSO No.	Basin area (sq. mi.)	Lane miles per square mile (mi/sq mi)[1]	Lane miles to be cleaned (mi.)	Basin street cleaning cost (1992 $'s)[2]
2	0.13	23	2.99	$ 1,495
3B	0.02	30	0.60	300
3C	0.03	23	0.69	345
6	0.93	23	21.39	10,695
7	0.29	30	8.70	4,350
10	0.11	30	3.30	1,650
12	0.52	32	16.64	8,320
14	0.12	23	2.76	1,380
15	0.19	23	4.37	2,185
16A	0.08	23	1.84	920
16B	0.11	30	3.30	1,650
18	0.02	23	0.46	230
19	0.06	30	1.80	900
20	0.61	26	15.86	7,930
22	0.06	23	1.38	690
23	0.25	32	8.00	4,000
24A	2.02	30	60.60	30,300
24B	0.03	30	0.90	450
25	0.04	26	1.04	520
26	1.47	32	47.04	23,520
33A	0.08	26	2.08	1,040
33B	1.88	26	48.88	24,440
33C	0.02	30	0.60	300
33D	0.07	30	2.10	1,050
34	2.11	26	54.86	27,430
38	0.11	26	2.86	1,430
39	0.08	26	2.08	1,040
40	0.08	30	2.40	1,200
41	0.13	24	3.12	1,560
42	0.12	23	2.76	1,380
Totals	11.77		325.40	$142,778

1. Lane miles per square mile are based on 23 miles for double block, 30 miles for single block, 32 miles for business district.
2. Costs were obtained from City street cleaning data and reflect cost of one cleaning using vacum air following conventional street cleaners.

TABLE 7-3. HIGH EFFICIENCY WATER DEVICES TO REDUCE BASE WASTEWATER FLOW[1]

		Volume of Flow Reduction				
Description	Cost $	Low (mgd)[2]	High (mgd)	Average (mgd)	Percent Reduction	Unit Cost per CSO Frequency Reduction ($/mgd)
New Construction Building Code Enforcement	8,400	0.024	0.044	0.034	0.19	$ 247,059
Commercial Toilet Retrofit	800,000	0.16	0.36	0.26	1.43	3,076,923
Voluntary Reduced Flow Shower Heads	1,496,000	0.84	2.04	1.44	7.91	1,038,889
Voluntary Residential Toilet Retrofit with Public Funding	22,000,000	2.6	3.84	3.22	17.69	6,832,298
TOTAL	24,304,400	3.62	6.28	4.95	27.22	4,906,015[5]

1. Adapted from Seattle data.
2. mgd = million gallons per day.
3. Spokane Total BWWF (mgd) = 18.20.
4. Reduction in 5-yr Combined Flow = 3.54%.
5. Average cost per mgd for all listed flow reduction alternatives.

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Public Education Programs: Public education programs can take several forms, depending upon the objective. Clean water campaigns to discourage dumping of used motor oil into public catch basins have been used in the Puget Sound area. Employees and customers of gas stations should be educated on the proper use of fuel dispensers (Ecology, 1992). Public participation in the decision-making prior to facility siting has also been used. Public participation does not guarantee that the general public will support a proposed facility, but a well-presented program will enable members of the general public to make an informed decision (Dr. Timothy McDaniels, 1991).

Inflow and Infiltration Reduction: The City is currently pursuing an aggressive I/I reduction program in the central business district, primarily by installing polymer sleeve liners inside identified leaking wastewater collection system pipes. This program should be expanded to include other areas of Spokane, first by I/I flow monitoring and analysis before proceeding with planning and design.

For the central business district, some of the largest components of wastewater flow are suspected to originate from inflow from unused service connections and roof drains, and basement sump pumps (Bovay, 1991). An alternative to address inflow from basement sumps and roof drains is to conduct a building-by-building investigation in cooperation with the owners to determine the extent of this inflow. A workable solution coordinated with building owners would be part of a plan generated in conjunction with the investigation, and might involve a new ordinance addressing disposal of basement groundwater infiltration and roof-intercepted storm water from within the central business district. The *Six-Year Comprehensive Sewer Program, 1993-1998*, has an allocation of $35,000 for an engineering study of infiltration and inflow. A study of central business district groundwater sump pumping would be included in this study. An additional study of roof-intercepted storm water quality and volume is proposed.

City Wastewater Ordinances: City wastewater ordinances may pass the financial responsibility for on-site storm water management from the city to the property owner. The City's drainage policy currently affects all new and redeveloped properties, reducing the City's financial responsibility for storm water removal in these areas. However, existing parking lots constructed before the current drainage ordinance was enacted add a significant amount of flow to the combined sewers during heavy spring and summer rainfalls. On many existing parking lots swale construction would require only minor modifications and would improve the appearance of these lots. Making parking lots more attractive with landscaping and providing access for pedestrians is being suggested by citizens groups around the city. The city may encourage grass swale construction through rate structure adjustments.

The City may enact an ordinance encouraging general reductions in peak storm water flow, including on-site retention as the preferred option, and on-site detention on roof-tops or parking lots. Such an ordinance would need to specify that runoff control structure plans be designed and stamped by a professional engineer and reviewed by public works department staff to ensure compliance with city drainage system limitations, soil permeability limitations and building code structural limitations.

An ordinance to reduce peak storm water flows originating on private property would be most effective for areas with a large proportion of impermeable surfaces, such as large roof-tops, driveways, and parking lots. Such land use areas include industrial, commercial and high-density residential land uses, and account for over 20 percent of the total combined sewered area in Spokane. For example, the central business district is nearly entirely commercial and high-density residential, and is drained by the highest volume overflow in the city. Enactment of a storm water retention/detention ordinance for redevelopment could gradually reduce overflow frequency and volume in the central business district. Selected roof drains may be piped to the Spokane River or to groundwater recharge infiltration basins. Roofs selected on a preliminary basis under this program would first be inspected and tested for runoff water quality.

Grass Retention Swales: City policy requires a grass swale area to retain the first half-inch of runoff from the impervious area of a new development. Ecology requires a Water Quality Standards Modification permit whenever a facility or construction operation discharges to waters of the state, including groundwater. A parking lot that has runoff discharging to a grass swale and not overflowing to a stream or dry well would probably not need a standards modification permit (Deborah Cornet, 1992).

There may be an additional cost for public involvement to enlist public support for on-site retention. Native soil which provides good drainage is important, as well as a large enough area contributing runoff to provide a significant reduction in storm water entering the combined sewer. The mention of potential for volume reduction using grass retention swales within basin BMP strategy descriptions in this Plan is intended as a general approach. Specific sites were selected only for development of costs considering soils, drainage characteristics, and other site-specific conditions. These costs are intended to be used only for comparison with the effectiveness and cost of other CSO reduction strategies in this Plan.

On-site Detention Storage: On-site detention (temporary storage) was considered in this CSO Reduction Plan separately from on-site retention (grass swales) to leave an option for on-site control in areas where retention strategies might not be practical. On-site

detention facilities for storm water store water for a relatively short period of time and, unless they are used for storm water quality enhancement, are primarily used to reduce the peak rate of flow downstream (Stahre and Urbonas, 1990). Detention time and flow rate would be controlled with a carefully selected automatic flow control device. Several areas of the City have been identified as candidates for storm water detention. The primary drawback to on-site detention is the large, shallow storage needed to significantly reduce storm peaks, and the fact that the storm water is still in the combined sewer system. On-site detention was not considered in areas where on-site retention appeared to be practical.

7.2.2 Basin Best Management Practice Analysis

This sub-section integrates the combinations of best management practices in each of the CSO basins. Table 7-4 lists projected flows resulting from implementation of proposed system-wide and basin-specific BMPs. Figure 7-3 shows the areas of the City that have been identified as candidates for storm water retention grass swales, including preliminary strategy selections as noted in the basin-specific information that follows. Preliminary site selections are subject to revision during basin plan preparation for each area. Details of the general grass swale sites are given in Table 7-5. As examples of major sites, potential on-site detention locations and preliminary strategy selections are shown in Figure 7-4. Table 7-6 provides details of the on-site detention options. Each basin is evaluated for infiltration in terms of gallons per day per inch-diameter-mile (gpd/idm). An inch-diameter-mile is an indication of a basin size calculated by multiplying the basin's pipe diameters by their respective lengths to obtain inch-diameter-feet, which is divided by 5,280 feet/mile. The area of the pipe in contact with the ground is generally proportional to the amount of base infiltration expected.

CSO Basin 2, Hartley and Northwest Boulevard: This basin, located in northwest Spokane and west of the advanced wastewater treatment plant, is entirely medium density residential as indicated in Table 3-3. There are no public parks or other public lands within the sewered area of this basin. As a result, a city-owned on-site grass swale within the basin was not considered as a preliminary option. The feasibility of pumping storm water from a separated sewer to a swale in the nearby Albi stadium parking area was investigated and found to be have a higher-than-average cost.

TABLE 7-4. MODELING CHARACTERISTICS AND RESULTS OF BEST MANAGEMENT PRACTICE IMPLEMENTATION

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1-YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT. FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Surro at S. Riverton	62006	42	0.33	6.12	0.17	4	2.00			2.0	2.0
Surro at S. Riverton	05087		0.11	0.19			0.19	2.0	2.0	2.1	2.5
Waterworks at S. Riverton	05085		0.17	0.32			0.32	2.1	2.5	2.0	1.2
Haven at S. Riverton	05059		0.26	0.45			0.45	2.0	3.7	3.9	12.2
North Valley Interceptor	05058		2.50	3.50			3.50	3.9	12.2	9.4	10.7
Rebecca at Upriver Dr.	56015	41	0.14	7.13	0.30	7	1.57			1.6	1.5
Green at Upriver Drive	56003		0.19	0.63			0.63	1.5	5.7	1.6	30.6
Regal at S. Riverton	57029	40	0.07	2.51	0.40	16	0.60			0.6	0.6
Altamont at S. Riverton	57017	39	0.16	1.82	0.37	20	0.28			0.3	0.3
Magnolia at S. Riverton	57001	38	0.22	5.81	0.28	10	0.69			0.7	0.7
Mission at S. Riverton	05033		0.15	0.51			0.51	10.1	16.2	10.7	16.7
Mallon at S. Riverton	05029		0.42	1.45			1.45	10.7	16.7	12.3	24.6
Front at S. Riverton	05025		0.21	0.38			0.38	12.3	24.6	14.7	25.1
Front at Erie	05023		0.17	0.69			0.69	14.7	25.1	15.5	24.7
Riverside at Napa/Crest.	07099	34	3.50	88.22	11.78	13	13.77			17.7	16.5
Napa at Riverside	59017		0.07	0.34			0.34	17.7	15.4	17.3	15.4
Madelia at Main	59014		0.08	3.33			4.22	17.3	15.4	16.9	15.4
Helena at Front	59011		0.36	11.73			14.75	16.9	15.4	17.2	15.8
Springfield at Superior	52002		0.29	0.98			0.98	7.2	16.2	10.7	16.7
South Valley Interceptor	05015		8.09	11.99			11.99	33.3	57.2	53.4	55.7
5th at Arthur	60396	33A	0.08	5.77	0.00	0	2.00			0.8	2.1
3rd at Perry	60077	33B	2.09	80.17	1.80	4	19.32	104.5	102.1	46.3	16.7
3rd at Arthur	60298	33C	0.06	2.78	0.12	11	0.45			0.3	0.5
1st at Arthur	60299	33D	0.09	14.08	2.03	42	0.76			0.8	0.8
Highdrive near 33rd	61299	20	0.14	0.54	0.00	0	0.64			6.8	6.5
Maple at 10th	55036		0.37	0.66			0.66	57.9	71.3	58.9	77.5
Cedar at Riverside	06014	24	3.30	54.17	2.12	3	12.20	58.8	77.7	68.0	118.7
Lincoln at Spokane Falls	06004	26	8.00	70.96	16.07	14	36.80	16.7	14.1	98.3	154.7
Division at Cataldo	04025		1.17	3.63			3.63			4.9	27.9
Howard at Mallon	04014		0.14	0.43			0.43	4.9	8.7	5.0	13.3
Cedar at Ide	36000	23	0.25	13.30	0.87	10	2.00			2.3	2.3
Sherwood at Summit	37299	14	0.10	5.65	0.86	17	0.80			0.8	0.8
Nettleton at Ohio	37099	15	0.33	5.53	1.41	19	1.97			2.9	3.1
Under Freeway Bridge[6]	43099	19	0.05	4.96	0.00	0	34.11			5.9	23.3
Coeur d'Alene at 14th	08017		3.10	11.46			11.46	11.5	44.8	11.5	28.6

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TABLE 7-4. MODELING CHARACTERISTICS AND RESULTS OF BEST MANAGEMENT PRACTICE IMPLEMENTATION (cont.)

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1-YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT. FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Cedar at Main	43029	25	0.12	0.06	0.00	0	0.09			0.3	0.6
Main at Elm St.	43014	22	0.16	3.75	0.00	0	2.20	0.3	0.6	1.2	2.1
"A" Street at Linton	02099	16B	0.26	9.59	0.50	12	1.27			2.5	2.9
"A" Street at Linton	02098	16A	0.24	3.95	0.01	0	2.90			2.5	3.0
1st at A street	02097	18	0.08	1.00	0.00	1	0.25			-0.3	0.3
"A" at 1st	08009		0.15	0.40			0.40	11.4	28.4	11.6	29.8
Nora at Pettet	35015	12	0.70	40.90	7.76	31	3.80			3.9	3.7
Cochran at Buckeye	30001	10	0.09	7.17	0.27	7	1.06			0.8	1.0
Cochran Sanitary	03000		6.68	31.33			31.33			133.5	117.6
Columbia Circle	24001	7	0.14	4.11	0.23	6	2.07			2.2	2.1
Kiernan at NW Blvd	29000	6	0.64	38.35	10.26	30	2.94			3.2	3.0
NW Blvd. at Hartley	20099	2	0.05	4.45	1.72	40	0.30			0.3	0.3
NW Blvd. at Assembly	20001	3C	0.07	2.11	1.94	51	0.47	7.2	7.2	7.3	7.1
NW Blvd. at Assembly	20034	3B	0.04	0.93	0.00	1	0.22			0.2	0.4
N.W. Blvd. at Assembly	01006		7.07	7.22			7.22	7.2	25.8	7.3	29.7
N.W. Blvd. at Assembly	01003		0.13	0.11			0.11	7.3	17.8	7.4	22.1
SAWTP[7]			49.06	79.11	61.27		128.17	128.6	125.2	128.6	146.0

1. BWWF = Base Wastewater Flow.
2. For unregulated flow, maximum intercepted flow shown is the 5-yr storm flow.
3. One-year storm flows include average base wastewater flows.
4. mgd = million gallons per day.
5. MG = million gallons.
6. Maximum intercepted flow is the 50-yr storm flow.
7. 2010 dry weather SAWTP flow estimated from the sum of input flows is 49.06 mgd.

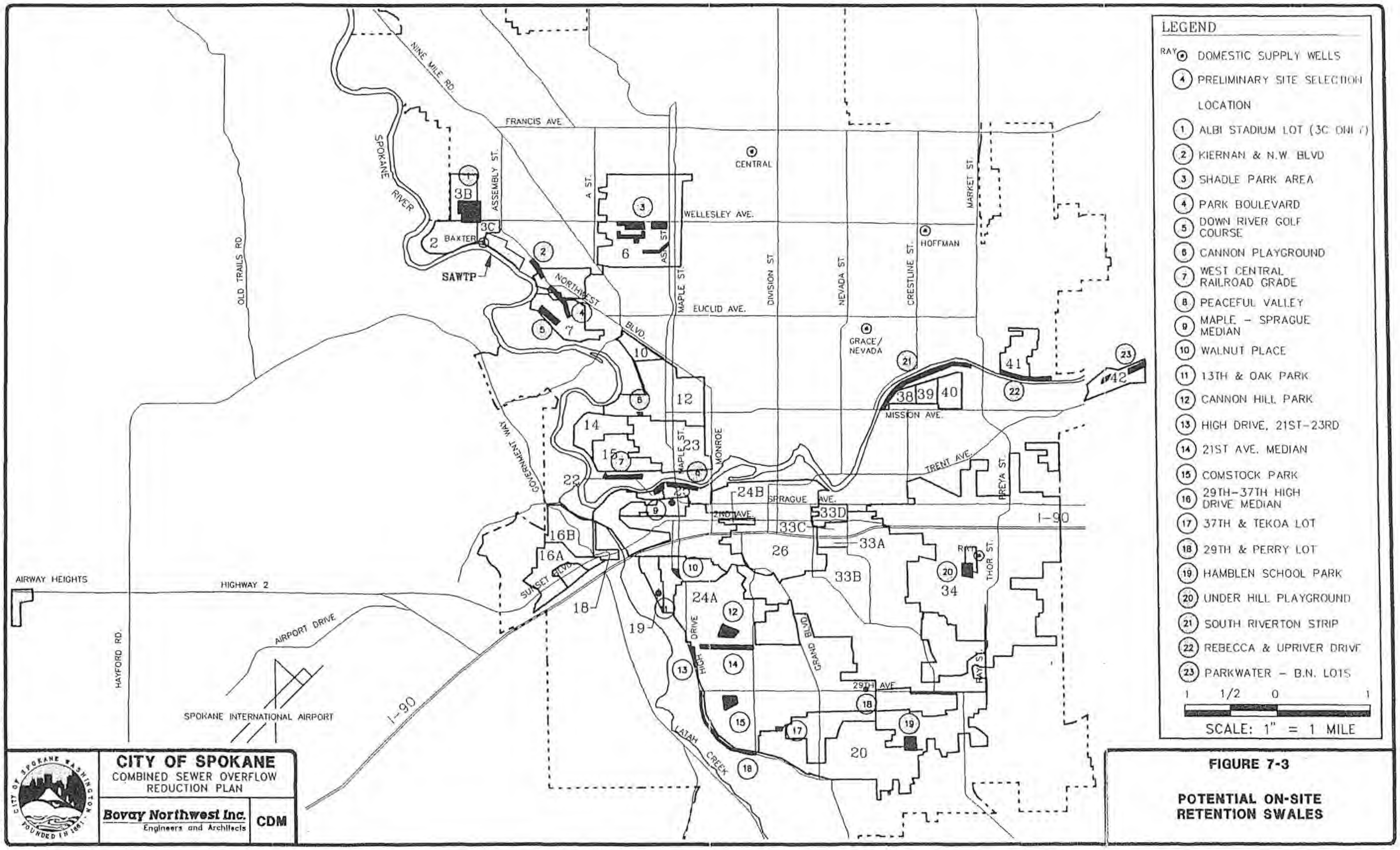

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TABLE 7-5. GRASS SWALE RETENTION OPTIONS

CSOs	Soil	Affected Area (acres)	Annual Overflow Volume with/without (MG)[1]	Annual Overflow Frequency with/without	Present Worth Capital Cost ($1000)	Annual Maintenance Cost ($1000)	Total Present Value[2] ($1000)	Figure 7-1 Area #/ Economic Impact
2	Springdale	84	0/1.7	0/40	147	42.2	705*	1/Moderate Cost
3C	Springdale	17	0/1.9	0/51	166	13.6	308*	1/Low Cost
6	Marble Loam	43	10.3/14.1	30/34	218	2.0	246	2, 3/Low Cost
7	Springdale	53	.23/.81	6/13	192	1.8	216	4, 5/Moderate Cost
12	Garrison	8	7.8/9.7	31/35	26	0.4	31	6/Low Cost
15	Garrison	54	1.4/4.5	19/34	286	2.7	323	7/Low Cost
20	Hesseltine	9	.11/.11	1/2	47	0.4	966	17/High Cost
24A	Hesseltine	148	1.4/2.1	3/3	794	7.6	897	10-16/High Cost
25	Springdale	24	0/.35	0/19	161	1.5	435*	8/High Cost
26	Basalt	156	16.1/19.7	14/15	22	0.3	27	9/Low Cost
33B	Marble Loam	30	1.8/2.3	4/5	162	1.5	182	18, 19/Moderate Cost
34	Marble Loam	69	8/11.8	12/13	172	2.8	877*	20/High Cost
38	Garrison	34	.01/.28	1/10	158	2.5	193	21/High Cost
39	Garrison	16	.37/1.06	20/34	51	0.8	62	21/Low Cost
40	Garrison	19	.4/1.45	16/32	60	0.9	73	21/Low Cost
41	Garrison	11	.3/.52	7/11	49	0.5	55	22/Moderate Cost
42	Garrison	9	.17/.31	4/7	48	0.4	54	23/Moderate Cost

* Includes Separation Costs

1. MG - million gallons
2. Total present value was determined using a 20 year project life and a 7 percent rate of return.

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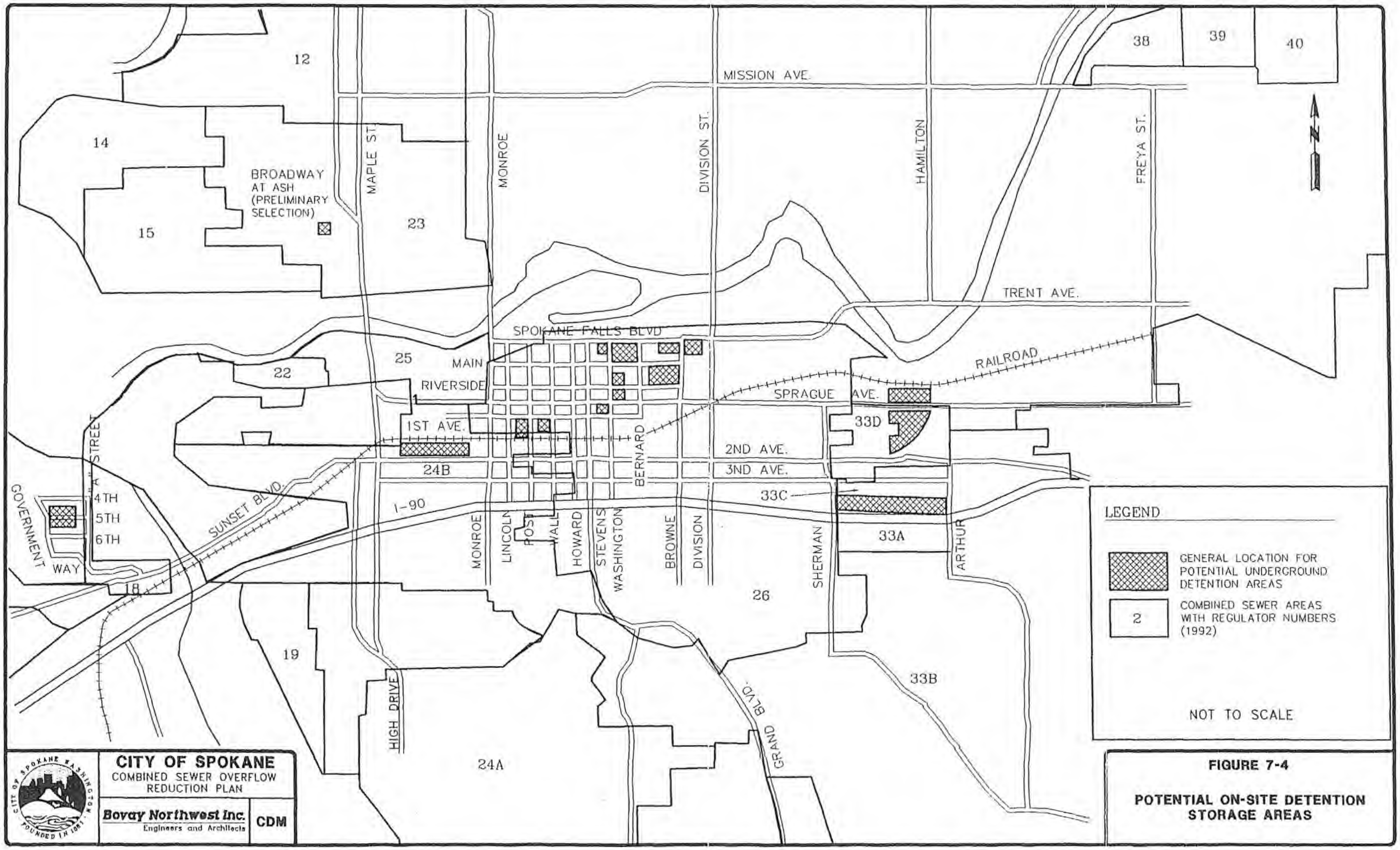

FIGURE 7-4

POTENTIAL ON-SITE DETENTION STORAGE AREAS

TABLE 7-6. ON-SITE DETENTION OPTIONS

CSOs	Storage Facility Location	Storage Volume (MG)[1]	Contributing Area (acres)	Annual Overflow Volume with/without (MG)	Annual Overflow Frequency with/without	Present Worth Capital Cost ($1000)	Annual Maintenance Cost ($1000)	Total Present Value[2] ($1000)	Economic Impact
16B	Govt. & 5th	2	75	124/.5	7/12	936	4.0	991	High Cost
23	Broadway & Ash	3.2	119	.87/1.7	10/18	1400	6.4	1486	Costly & Effective
26	SF & Stevens	0.2							All very high cost in downtown area.
	SF & Washington	0.91							
	SF & Bernard	0.41							
	SF & Browne	0.52							
	Main & Washington	0.28							
	Riverside & Wash.	0.23							
	Sprague & Stevens	0.2							
	1st & Lincoln	0.42							
	1st & Post	0.28							
	Total CSO 26 Det. Stor.:	4.1	150	17.0/19.7	13/15	2299	8.2	2410	
33C	3rd & Arthur	1.1	14	.03/.12	3/11	618	2.2	648	High Cost
33D	1st & Arthur	1.7	45	.86/2.0	20/42	954	3.4	1000	High Cost

1. MG = million gallons
2. Total present value was determined using a 20 year project life and a 7 percent rate of return.

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Analysis of the flow pattern at the CSO 2 regulator indicates that infiltration is relatively minor in this basin, less than 500 gpd/idm. The existing leaping weir regulator, located on a steep hill-side, is relatively difficult to access, but the regulating chamber has a 5-foot, 9-inch invert from the ground surface.

CSO Basin 3B, Albi Stadium: This basin meets the one event per year criteria.

CSO Basin 3C, Royal Court: This basin is adjacent to CSO basin 2, and is a residential area along Royal Court. The land use character of this basin is essentially the same as that of CSO basin 2. The most cost effective and beneficial BMPs in the preliminary selection are separation, pumping and retention swale construction, and regulator replacement.

Separated storm water would be piped to a sump, where storm water would be pumped to a grass swale located in the Albi Stadium parking area. Alternatively, storm water may be piped to grass retention swales located on terraces on the hillside south of the intersection of Northwest Boulevard and Assembly.

The interceptor chamber containing the regulator has not been located in the field, and as a result the actual condition of the regulator is not known. The approximate location of the regulator is on a steep slope above the headworks building of the advanced wastewater treatment plant.

CSO Basin 6, Regulator near Kiernan and Northwest Boulevard: This CSO basin is the largest remaining in the north Spokane area, and includes the 29 acre Shadle Park shopping center and large parking lots by Glover Middle School and Shadle Park High School. The rest of the basin is primarily residential.

Preliminary analysis indicates that construction of retention swales in the Shadle Shopping Center parking lot and along the south side of Northwest Boulevard will reduce storm water flow routed through the CSO 6 regulator. As a result, grass swales in these areas were selected as sites at this planning level. Separation of this basin was found to have a high cost per gallon of reduced CSO, making separation and disposal of separated storm water to retention swales unlikely.

The monitored flow pattern at this regulator indicates an absence of high dry weather groundwater infiltration in the basin, at less than 100 gpd/idm. Monitoring has been conducted since November, 1991. The existing regulator is a leaping weir in a 36 inch pipe. The intercepted flow is now routed through an 8-inch pipe that frequently surcharges according to model analysis. This existing intercepting pipe should be replaced. The invert below ground level of the existing regulating chamber is 7-feet,

3-inches. The chamber extends downstream of the leaping weir chamber into a second diversion chamber with two effluent pipes discharging to separate Spokane river outfalls.

CSO Basin 7, Columbia Circle: This basin, next to Downriver Municipal Golf Course, is generally an older residential development. There are two large grassy areas analyzed for use as on-site grass swales, for cost analysis only; a park along Park Boulevard and Downriver golf course. If street gutter drains are used, the area available for drainage is limited to that within two blocks and upstream of the potential grass swales. If the area is separated in the future, then storm water could be routed to irrigate Park Boulevard park and the golf course. Potential disadvantages to irrigating with storm water include the potential for flooding, insuring sufficient treatment, and the temporary loss of use of the swale area for playing golf during large storm flows. Potential advantages include less irrigation water needed from the municipal water supply. The selected practice is to prepare grassy swales draining only the areas within two upgradient blocks of the swales.

Analysis of the flow pattern at the CSO 7 regulator indicates that infiltration is relatively minor in this basin, at less than 500 gpd/idm. The existing regulator for CSO basin 7 is a leaping weir located next to Columbia Circle in a chamber with an invert below ground level of 6-feet, 7-inches. The existing regulator chamber has a diameter of 4 feet, so that a new, larger chamber may be required to house a new overflow control device.

CSO Basin 10, Buckeye: CSO Basin 10 is located south and east of the intersection of Northwest Boulevard and T.J. Meenach Drive. There is a strip of commercial land use along the south side of Northwest Boulevard that is included in the basin. The park area between Northwest Boulevard and T.J. Meenach Drive may be usable as a grass swale if this basin is separated. The existing regulator is upstream of the park, which facilitates routing a separate storm sewer to the potential swale area. However, separation for this basin was found to be relatively expensive per gallon of CSO reduction.

Monitoring data indicates that there is a significant amount of groundwater infiltration within this basin, approximately 1,600 gpd/idm, which might be reduced by lining or replacing the existing sewer pipe. The regulator for CSO basin 10 is a 4-inch high side weir, located in a relatively deep chamber with a 21-feet, 6-inch depth below ground level.

CSO Basin 12, Regulator North of Pettet and Nora: This basin is bounded on the north by Northwest Boulevard and on the east by Monroe Street; to the south is Sharp Avenue. The basin land use is 26 percent commercial and industrial, 4 percent high-density residential and the remaining 70 percent is medium density residential.

Cannon Playground, adjacent to the West Central Community Center, already has a grass swale receiving runoff from the community center parking lot. This grass swale was analyzed for expansion to accept storm water from the area north of the playground. This swale is a preliminary strategy selection. There are not any additional areas within this basin identified to retain storm water runoff.

This basin has been monitored since October, 1989. The monitoring data indicates that a significant proportion of the base wastewater flow may be from groundwater infiltration or dry weather inflow. An I/I investigation of this basin could help identify cost effective flow reduction projects. The regulator for CSO basin 12 is a leaping weir located in a chamber with an invert below ground level of approximately 12-feet.

CSO Basin 14, Regulator at Summit and Sherwood, South Intersection: The basin drained by CSO regulator 14 has only medium density residential land use, and is located west of CSO basin 12. There are no identified public parks or other public lands with sufficiently flat topography for grass swales within the sewered area of this basin. The only transportation arterial in the basin is Summit Boulevard, which is free of commercial development and does not have noticeable refuse.

Monitoring data indicates that groundwater infiltration is not significant at about 500 gpd/idm. The regulator for CSO basin 14 is a leaping weir located in a moderately deep chamber with an invert below ground level of 15-feet, 6-inches.

CSO Basin 15, Regulator at Nettleton and Ohio: This basin is hydraulically below CSO regulator 14. The land use is low and medium density residential, with some unpaved streets included. The unpaved streets may contribute significant amounts of sediment during storm runoff events. Paving these streets may be beneficial in reducing pollutant loads to the wastewater collection system, but may increase storm water runoff. The benefits of paving additional streets should be studied for this area.

Between Bridge and Ohio Avenues and west to Summit Boulevard is an abandoned Milwaukee Railroad right-of-way. The portion of the area bordered on the north by Bridge Avenue was analyzed for use as a grass swale area, accepting storm flow from the area south of Broadway. This grass swale is a preliminary strategy selection, to be studied in the basin plan for this CSO basin. Separation was found to have a relatively high cost per gallon of reduced CSO volume, therefore was not evaluated for integration with storm water retention for this basin.

The CSO 15 regulator was monitored from December 1989 through October 1991. Monitoring data indicates that high groundwater infiltration is relatively minor in this

basin. The invert depth below ground level of the regulating chamber is approximately 12-feet. The regulator is a leaping weir.

CSO Basin 16A, Geiger: This basin meets the one event per year criteria.

CSO Basin 16B, West Grove: This basin is located west of "A" street, primarily in a medium density residential subdivision north of Finch Arboretum and east of Indian Canyon Municipal Golf Course. There are large stands of Ponderosa Pine trees in and surrounding the subdivision. Several streets in this basin are unpaved, which may contribute to higher sediment loadings, but may also prevent some portion of storm event runoff from reaching the combined sewer collection system.

There have not been any public lands identified that could serve as grass swales. The dominant soil type in this basin is not conducive to storm water infiltration; however, retention should be studied in the basin plan for this CSO basin.

Monitoring data from November 1991, indicates that high groundwater infiltration may be a major component of base flow from this basin, at over 3,000 gpd/idm. More extensive I/I investigation is recommended in this basin. Since excavation in this area may be difficult due to the shallow basalt bedrock, lining the existing pipe may be the most cost-effective I/I reduction technique. The existing regulator is located in a 9-feet, 9-inch deep chamber at "A" and Linton, near the Spokane River above the mouth of Latah Creek.

CSO Basin 18, Federal Housing Authority Sewer: This basin meets the one event per year criteria.

CSO Basin 19, Regulator Below Freeway Bridge: This basin meets the one event per year criteria.

CSO Basin 20, Regulator West of High Drive, South of 33rd Avenue: This basin nearly meets the one event per year criteria. The basin above the regulator, bounded on the South by High Drive, and on the east by Perry Street; it is partially separated. A parallel 18-inch line carries flow from some separated portions of the basin, and the regulator structure controls flows originated from both combined sewer areas and separated storm sewers. There is an existing 36-inch storm water outfall line near Hatch Street and south of High Drive that could be utilized to carry all separated storm flow from the basin. This would reduce the storm flow through the CSO 20 regulator, and reduce its CSO frequency to less than one event per year.

It may be possible to divert the storm outfall to a terraced grass swale system on the hillside south of the High Drive and Hatch Street intersection.

Monitoring data from November 1991, indicate that a high percentage of the base wastewater flow may be due to high groundwater infiltration. Specific gallon per day per inch-mile data was not available. Reduction of I/I in this basin would affect flows at CSO regulators 24A and 26. An I/I investigation should be conducted in this basin to determine the most likely areas for collection system pipe repair or replacement.

CSO Basin 22, Main at Oak Regulator: This basin meets the one event per year criteria.

CSO Basin 23, Regulator Located at Cedar and Ide: The Spokane County Courthouse, Spokane County Health Building and other Spokane County offices are in the east portion of this basin. The commercial area north of Broadway along Maple and Ash to Sharp Avenue is included in this basin. The total commercial land use area is nearly half of the total basin area. An on-site storage retention/detention ordinance for this area may need to be weighted toward encouraging detention storage for redeveloped properties, since much of the soil may be unsuitable for efficient infiltration.

A detention storage site located south of Broadway and east of Ash is a preliminary strategy selection. This facility would detain flows from about 50 percent of the basin. It could be located below the existing parking lot on the site. The detention storage option should be used if other flow reduction techniques are not adequate to bring overflow frequency to less than one event per year.

This basin has been monitored since November 1991. Monitoring data indicates that there may be high groundwater infiltration in this basin, approximately 2,300 gpd/idm. More extensive I/I monitoring is recommended to determine actual source areas where wastewater collection pipes should be repaired or replaced. The existing CSO 23 regulator is a leaping weir located within a 7-foot, 8-inch deep chamber.

CSO Basin 24A, Regulator at Cedar and Riverside, South Hill Basin: On the west end of the south hill of Spokane, this basin is located downstream of CSO regulator 20 and upstream of CSO regulator 26. It is the second largest Spokane CSO basin controlled by a single regulator. The land use is predominately residential, with less than two percent zoned commercial. The major arterials through the basin, Maple, Walnut, Cedar, High Drive, Monroe, Lincoln, Grand Boulevard and 29th Avenue may contribute significant sediment loads to the wastewater collection system.

Several potential grass swale areas were investigated. These areas are shown in Figure 7-3. Generally, they were sized to accept flow from areas within two blocks upgradient of the grass swale sites. The preliminary determination for this basin is that it will be more cost effective to use central off-line storage than to use grass swales. However, the basin plan for this basin should examine the cost effectiveness of each of the grass swales identified in Figure 7-3.

CSO regulator 24A has been monitored since November 1991. Monitoring data indicates that there may be a significant percentage of the base wastewater flow due to high groundwater infiltration, though specific gallon per inch-mile data is not available. Some I/I investigation was conducted in this basin in March and April 1990. The preliminary results of that study were published in the 1991 Draft *Wastewater Facilities Planning Study,* (Bovay, et al, 1991).

The leaping weir regulator of CSO 24A was constructed from 2 curved sections of half-inch steel plate, and is 59-inches in length and is 134 degrees of a 48-inch diameter circle. The regulator chamber invert is approximately 20 feet below the street surface.

CSO Basin 24B, Regulator at Cedar and Riverside, Second Avenue Basin: This basin is approximately 20 acres, primarily along Second Avenue east of Cedar Street. The regulator was located during preparation of this Plan; as a result no model analysis has been done for this basin. However, it is unlikely to overflow frequently because the side overflow is 8-inches above the influent pipe invert, and within 5 linear feet downstream of the side overflow point is a 9-inch high dam that must be overtopped prior to overflow reaching the Spokane River.

CSO Basin 25, Regulator at Cedar and Main: This basin is located primarily along Main Avenue west of Monroe Street. The land use is almost 50 percent commercial, and 30 percent high density residential.

A grass swale was analyzed below the Maple Bridge in a city park on the south bank of the Spokane River for use in retaining separated storm water from this basin. This is the preliminary strategy selection for this area to reduce overflow frequency below one event per year, which should be studied further in the basin plan for this CSO basin.

More extensive I/I monitoring should be conducted in conjunction with preparation of the basin plan for this basin. Limited monitoring in November 1991, indicated that high groundwater infiltration or inflow may be a significant percentage of base wastewater flows, at 3,700 gpd/idm. The invert elevation of the regulator chamber is 9-feet, 6-inches below the street surface. The existing regulator is a 2-inch high diversion dam.

CSO Basin 26, Regulator at Lincoln and Spokane Falls: CSO Basin 26 includes the central business district, with 4 percent of the area zoned medium density residential. Since the majority of surfaces in this area are impermeable and streets have a high traffic volume, there may be a high concentration of hydrocarbon pollutants collected regularly.

A City drainage ordinance encouraging on-site retention/detention may be effective in this basin if roof-top storage is utilized. Other means of disposing of roof-intercepted storm water should be examined in the basin plan for this CSO basin. There is little open space for grass swales, and open space in Riverfront park is over shallow basalt and a high water table which makes retention generally non-feasible in this basin.

This basin has been monitored since October 1989. Monitoring data indicates that high groundwater infiltration is gradually coming under control in this basin, probably due to a long-term City sewer pipe repair program using "in-situ-form" lining. Additional I/I studies should concentrate on detecting suspected groundwater pumping from basement sumps into the collection system.

The existing regulating chamber has an invert depth of approximately 18-feet below the street and is at the north end of a 66-inch concrete pipe that discharges dry weather flow to a 42-inch intercepting pipe. Overflow is routed to a 48-inch corrugated metal pipe that discharges below the Monroe Street Bridge. The entire chamber may need replacement in order to provide a more accurate and adjustable regulating structure, something that should be studied in the basin plan for this basin.

CSO Basin 33A, Regulator at Fifth and Arthur: This basin meets the one event per year criteria.

CSO Basin 33B, Regulator at Third and Perry: CSO basin 33B is the third largest combined sewer basin in Spokane, located on the central south hill and extending north to Liberty Park. The land use is over 98 percent medium density residential.

Two sites within this basin were identified as potential on-site grass swales. The double lot to the north and west of the intersection of 29th and Perry is undeveloped, probably because of the site topography. With some earth work, this site may be suitable for receiving storm water from the two block area south of 29th. Similarly, an undeveloped four block area north of Hamblen school may be modified to retain and infiltrate storm water from the area to the south and west. Both of these retention projects have been selected as preliminary strategies, but both require more study and design to consider their ultimate feasibility.

This basin was monitored in October and November 1989, and determined at that time to overflow less frequently than the estimate in the 1972 *Spokane Action Plan* (Bovay, et al, 1991A). At that time, monitoring indicated that average high groundwater infiltration was a moderate contribution to base wastewater flow. However, the 1990 I/I investigation indicated that the sub-basin along Pittsburgh Street south of Rockwood Boulevard had a very high groundwater infiltration rate. More extensive I/I investigation should be conducted in this large basin to isolate additional sources of I/I.

The existing regulating chamber is a 24-foot by 17-foot vault, located in the north-side I-90 freeway right-of-way and southwest of the intersection of Second Avenue and Perry Street. The regulator comprises side overflow weirs on either side of a channel tapering from the 69-inch influent pipe to the 36-inch intercepted effluent pipe. The invert depth of the channel is about 10 feet below ground level. The existing structure was prone to siltation following storm events, which was corrected by replacing a large corrugated pipe in Liberty Park with a reinforced concrete pipe.

CSO Basin 33C, Regulator at Third and Arthur: This small basin drains a commercial area to the north of the freeway between Arthur and Sherman Streets. This area was investigated for possible detention storage, but the estimated cost per gallon of CSO reduction was relatively high.

This basin has not been continuously monitored to date. Overflow frequencies were estimated based on the land use characteristics, observed overflows following chalking of the overflow pipe, and data from similar basins elsewhere in the city. Since most of the collection system pipe is over 40 years old and located in shallow basalt, it is likely that this basin has at least seasonal high groundwater infiltration. This should be investigated further during preparation of the basin plan for this basin. The existing regulator, a leaping weir, is located in a chamber with an invert depth of approximately 8-feet below street level.

CSO Basin 33D, Regulator at First and Arthur: This basin shares many of the characteristics of CSO basin 33C, and is located adjacent to and north of that basin. This basin was assessed for detention storage, which was found to have a relatively high cost per gallon of CSO reduction.

This basin has not been continuously monitored to date. Overflow frequencies were estimated based on the land use characteristics, observed overflows following chalking of the overflow pipe, and data from similar basins elsewhere in the city. Because most of the collection system pipe is over 40 years old and located in shallow basalt, it is likely that this basin has seasonal high groundwater infiltration. This should be investigated further during preparation of the basin plan for this basin. The existing regulator, a

leaping weir, is located in a chamber with an invert depth of approximately 22-feet below ground level. The access manhole is in the fenced right-of-way west of the south abutment of the Hamilton Street Bridge and about 175-feet south of Sprague Avenue.

CSO Basin 34, Regulator Between Napa and Crestline on Riverside: This basin, located on the east side of Spokane's south hill, is the largest combined sewer basin with storm flow controlled by a single CSO regulator. The land use is primarily medium density residential, with approximately 20 percent of the basin land use being high density residential, commercial or industrial.

Underhill playground was identified as a study site for a storm water grass swale. Storm water would need to be separated south of 11th in CSO basin 34 to route flows to Underhill Park. Because of the estimated separation cost this alternative was determined to have a relatively high cost per gallon of CSO volume reduction.

This CSO basin has been monitored since October 1989. The monitoring data indicates that high groundwater infiltration periodically contributes a significant percentage of the average daily base wastewater flow in CSO basin 34, though specific gpd/idm figures are not available. More extensive I/I investigation should be completed as part of the basin plan for this basin.

The existing regulator is a diversion dam in a chamber approximately 10-feet deep below street level. The monitoring data from this regulator appears to be accurate in determining overflow volume. The basin plan should evaluate relocation of the regulator to a new chamber at or near the intersection of Front and Erie.

CSO Basin 38, Regulator North of South Riverton at Magnolia: Three CSO basins, 38, 39 and 40, are arrayed from west to east, respectively, south of South Riverton and north of Mission Avenue. There are no major arterials in CSO basin 38, which has a generally medium density residential land use.

A grass swale north of South Riverton was evaluated for CSO basin 38 and found to have a relatively high cost per gallon of CSO volume reduction. Monitoring data obtained during November 1991, indicates that high groundwater infiltration is a relatively small component of total base wastewater flow, at about 500 gpd/idm. The leaping weir regulator is located in a chamber with an invert depth of 10-feet, 10-inches below ground level.

CSO Basin 39, Regulator North of South Riverton at Altamont: This basin is adjacent to and east of CSO basin 38. It is also a medium density residential land use basin without major arterials. A grass swale north of South Riverton was evaluated for

this basin. The estimated cost per gallon of CSO volume reduction was found to be relatively cost effective, and as a result a grass swale in this area is a preliminary strategy selection.

Monitoring data from the November 1991 monitoring of this regulator indicates that high groundwater flow is of minor significance as a component of base wastewater flow, at about 500 gpd/idm. The regulator, a leaping weir, is located in a chamber with an invert depth of 8-feet, 9-inches below ground level.

CSO Basin 40, Regulator North of South Riverton at Regal: This basin is adjacent to and east of CSO basin 39. It is also a medium density residential land use basin without major arterials.

A grass swale north of South Riverton was evaluated for this basin. The estimated cost per gallon of CSO volume reduction was found to be relatively cost effective, and as a result a grass swale in this general area is a preliminary strategy selection.

Monitoring data from the November, 1991 monitoring of this regulator indicates that high groundwater flow is a moderately significant component of base wastewater flow at 800 gpd/idm. More extensive I/I investigation is recommended as part of the basin plan for this CSO basin. The regulator, a leaping weir, is located in a chamber with an invert depth of 10-feet, 8-inches below ground level.

CSO Basin 41, Regulator South of Upriver Drive at Rebecca: This basin is on the north side of the Spokane River and east of Greene Street. Freya Street is the main arterial through the basin.

A grass swale south of Upriver Drive was evaluated for this basin. The estimated cost per gallon of CSO volume reduction was found to be relatively cost effective, and as a result a grass swale in this general area is a preliminary strategy selection.

Monitoring data from the November, 1991 monitoring of this regulator indicates that high groundwater flow is a moderately significant component of base wastewater flow at 700 gpd/idm. More extensive I/I investigation is recommended as part of the basin plan for this CSO basin. The regulator, a leaping weir, is located in a chamber with an invert depth of 11-feet, 8-inches below ground level.

CSO Basin 42, Regulator Along Surro South of South Riverton: This CSO basin is the farthest upriver in Spokane. Paving as a means for reducing sediment and pollutant loads should be studied versus the cost of handling increased runoff from a paved area.

Grass swales located along Union Avenue may be a cost effective control to reduce storm water flow to the collection system. The two potential swale sites identified during preparation of this Plan are shown in Figure 7-3. Swales in the general area are preliminary strategy selections.

Monitoring data indicate that high groundwater infiltration is a major component of base wastewater flow, at approximately 4,400 gpd/idm. A concerted I/I identification effort should be part of the basin plan for this basin. The side weir overflow regulator has a height of 8 inches. The regulator chamber invert depth is 7-feet, 4-inches below street level.

7.3 OPTIMIZATION AND STORAGE STRATEGY OPTION

7.3.1 Introduction

Interceptor optimization and storage is a strategy to utilize the interceptor system to convey storm flow from relatively low volume CSO regulators and from selected storage sites along the interceptor to the advanced wastewater treatment plant. The low volume CSO regulators would be adjusted to overflow once per year or less. Higher volume CSO regulators would discharge directly to storage facilities. This strategy may be adopted following completion and evaluation of the best management practice strategies described in Section 7.2.

The adopted strategy was first derived by selecting weir settings that allowed the maximum flow into the interceptor without surcharge, with the goal being to reduce overflow frequencies to one event per year, as modeled with the CSO basin simulation model, STORM. The hypothetical best weir settings were tested on the SWMM computer model to check the effect on downstream capacity. Storage structure locations were selected based on predicted bottlenecks to flow in the interceptor. In modeling, hypothetical flow was allowed to exit the interceptor system into the simulated storage structures. The apparent most cost effective projects for each CSO basin were then combined into a system simulation to judge the impact on the interceptor system, and predict any upgrades to the interceptor pipes. The results of this analysis are in Appendix N. The anticipated behavior of the system is shown in Table 7-7.

TABLE 7-7. MODELING CHARACTERISTICS AND RESULTS OF OPTIMIZATION AND STORAGE

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1-YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT. FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Surro at S. Riverton	62006	42	0.33	9.70	0.07	1	2.20			2.2	3.4
Surro at S. Riverton	05087		0.11	0.19			0.19	2.2	3.4	3.7	3.7
Waterworks at S. Riverton	05085		0.17	0.32			0.32	3.7	3.7	3.7	3.7
Haven at S. Riverton	05059		0.26	0.45			0.45	3.7	3.7	5.6	12.2
North Valley Interceptor	05058		2.50	3.50			3.50	5.6	12.2	9.1	10.7
Rebecca at Upriver Dr.	56015	41	0.14	11.37	0.05	1	1.60			1.6	1.6
Green at Upriver Drive	56003		0.19	0.63			0.63	1.5	5.7	1.7	30.6
Regal at S. Riverton	57029	40	0.07	5.90	0.03	1	2.01			0.6	0.6
Altamont at S. Riverton	57017	39	0.16	3.53	0.01	1	0.80			0.3	0.3
Magnolia at S. Riverton	57001	38	0.22	5.81	0.02	1	1.33			0.7	0.7
Mission at S. Riverton	05033		0.15	0.51			0.51	8.7	16.2	12.2	16.7
Mallon at S. Riverton	05029		0.42	1.45			1.45	12.2	16.7	12.6	24.6
Front at S. Riverton	05025		0.21	0.38			0.38	12.6	24.6	14.7	25.1
Front at Erie	05023		0.17	0.69			0.69	14.7	25.1	15.5	24.7
Riverside at Napa/Crest.[6]	07099	34	3.50	81.65	0.46	1	32.14			47.6	55.7
Napa at Riverside	59017		0.07	0.34			0.34			0.3	15.4
Madelia at Main	59014		0.08	3.33			4.22	0.3	15.4	3.0	15.4
Helena at Front	59011		0.36	11.73			14.75	3.0	15.4	7.6	15.8
Springfield at Superior	52002		0.29	0.98			0.98			0.6	0.7
South Valley Interceptor	05015		8.09	11.99			12.00	41.5	57.2	60.2	60.7
5th at Arthur	60396	33A	0.08	5.77	0.00	0	2.00			0.8	2.1
3rd at Perry	60077	33B	2.09	99.57	0.34	1	27.97	99.6	102.1	18.1	16.7
3rd at Arthur	60298	33C	0.06	2.78	0.02	1	0.82			0.3	0.5
1st at Arthur	60299	33D	0.09	14.08	0.05	1	2.73			0.8	0.8
East Trent Storage[7]	05009				2.93	1	34.4	72.4	78.2	48.4	51.6
Highdrive near 33rd	61299	20	0.14	0.54	0.00	0	0.64			6.8	6.5
Maple at 10th	55036		0.37	0.66			0.66	49.8	71.3	66.0	77.5
Cedar at Riverside	06014	24	3.30	54.17	1.00	1	12.20	65.4	77.7	13.0	14.1
Lincoln at Spokane Falls	06004	26	8.00	85.30	2.04	1	36.80	89.7	154.7	36.8	36.6
Division at Cataldo	04025		1.17	3.63			3.63			4.9	27.9
Howard at Mallon	04014		0.14	0.43			0.43	4.9	8.7	5.0	13.3
Cedar at Ide	36000	23	0.25	12.97	0.05	1	3.50			3.5	4.2
Sherwood at Summit	37299	14	0.10	5.65	0.02	1	2.01			2.0	2.0
Nettleton at Ohio	37099	15	0.33	8.93	0.09	1	4.83			4.8	4.8
Under Freeway Bridge[8]	43099	19	0.05	4.96	0.00	0	34.11			4.8	23.3

TABLE 7-7. MODELING CHARACTERISTICS AND RESULTS OF OPTIMIZATION AND STORAGE (cont.)

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1-YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT. FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Coeur d'Alene at 14th	08017		3.10	11.46			11.50			18.9	28.6
Cedar at Main	43029	25	0.12	0.06	0.00	0	0.09			0.1	0.6
Main at Oak St.	43014	22	0.16	3.75	0.00	0	2.20	0.1	0.6	1.2	2.1
"A" Street at Linton	02099	16B	0.26	9.59	0.02	1	2.49			2.6	2.9
"A" Street at Linton	02098	16A	0.24	3.95	0.01	0	2.90			2.1	3.0
1st at A street	02097	18	0.08	1.00	0.00	1	0.25			0.3	0.3
"A" at 1st	08009		0.15	0.40			0.40	18.8	28.4	18.9	29.8
Nora at Pettet	35015	12	0.70	50.14	0.61	1	5.80			5.8	5.8
Cochran at Buckeye	30001	10	0.09	7.17	0.02	1	1.70			1.7	2.0
Cochran Sanitary	03000		6.68	31.33			31.33			133.5	117.6
Columbia Circle	24001	7	0.14	10.29	0.10	1	4.21			4.2	4.2
Kiernan at NW Blvd	29000	6	0.64	48.95	0.44	1	2.94			2.9	2.9
NW Blvd. at Hartley	20099	2	0.05	4.45	0.01	1	1.10			1.1	2.8
NW Blvd. at Assembly	20001	3C	0.07	2.11	0.02	1	1.12	1.0	7.2	3.0	7.1
NW Blvd. at Assembly	20034	3B	0.04	0.93	0.00	1	0.22			0.2	0.4
N.W. Blvd. at Assembly	01006		7.07	7.22			3.02	15.5	25.8	15.8	29.7
N.W. Blvd. at Assembly	01003		0.13	0.13			0.11	16.2	17.8	16.0	22.1
SAWTP[9]			49.07	87.53	8.40		136.60	136.6	125.2	136.6	146.0

1. BWWF = Base Wastewater Flow.
2. For unregulated flow, maximum intercepted flow shown is the 5-yr storm flow.
3. One-year storm flows include average base wastewater flows.
4. mgd = million gallons per day.
5. MG = million gallons.
6. Flow calculated assuming the existing overflow pipe converted back to combined flow, overflowing at Front and Erie.
7. The proposed East Trent storage site is not an existing overflow; the maximum intercepted flow is the maximum combined flow that bypasses the storage facility.
8. Maximum intercepted flow is the 50-yr storm flow.
9. 1990 dry weather SAWTP flow estimated from the sum of input flows is 52.37 mgd.

Monitoring and modeling indicate that there is sufficient interceptor capacity below some CSO regulating structures to consider allowing more flow into the interceptor system to prevent frequent overflows. This section includes a discussion of each regulator structure's potential for optimization, based on current base and peak flows. Those regulators considered as preliminary strategy selections are shown in Figure 7-5. The estimated annual overflow frequencies and volumes of potentially modified CSO regulator overflow settings are in Table 7-8. Regulator overflow settings might be reset following replacement as detailed in Section 7.2. The costs in Table 7-8 include construction for increased treatment plant hydraulic peak capacity and treatment.

Storage facilities arranged along the interceptor can be used to store peak flows diverted from the interceptor for later treatment, saving interceptor and treatment plant hydraulic capacity for treating more peak sanitary wastewater flow. Storage facilities used together with optimization can provide the benefits of decreased CSO frequency and volume while reducing peak storm flows in the interceptor and to the SAWTP.

Storage options include on-site detention storage; in-line storage, including utilization of existing interceptor storage capacity and building new facilities; off-line storage; and combinations of in-line and off-line storage. On-site detention storage is treated along with BMPs described in Section 7.2. This section discusses the storage options located along the interceptor system.

Figure 7-6 shows locations of potential in-line or off-line interceptor storage facilities. All of these locations have fairly large parcels of land available and are located where construction of storage facilities is feasible. This includes the larger CSO basins and reaches of interceptor carrying combined sewer flow.

The storage facilities described in this section were sized to fill at storms exceeding the 1-year design storm defined in Chapter 4, Section 4.4.5. For storage structures to effectively reduce CSO volume and frequency, the CSO regulators upstream of the structure would require modification to allow increased flow to the interceptor. In some cases additional interceptor capacity would need to be constructed, which add to the cost of optimization-storage alternatives.

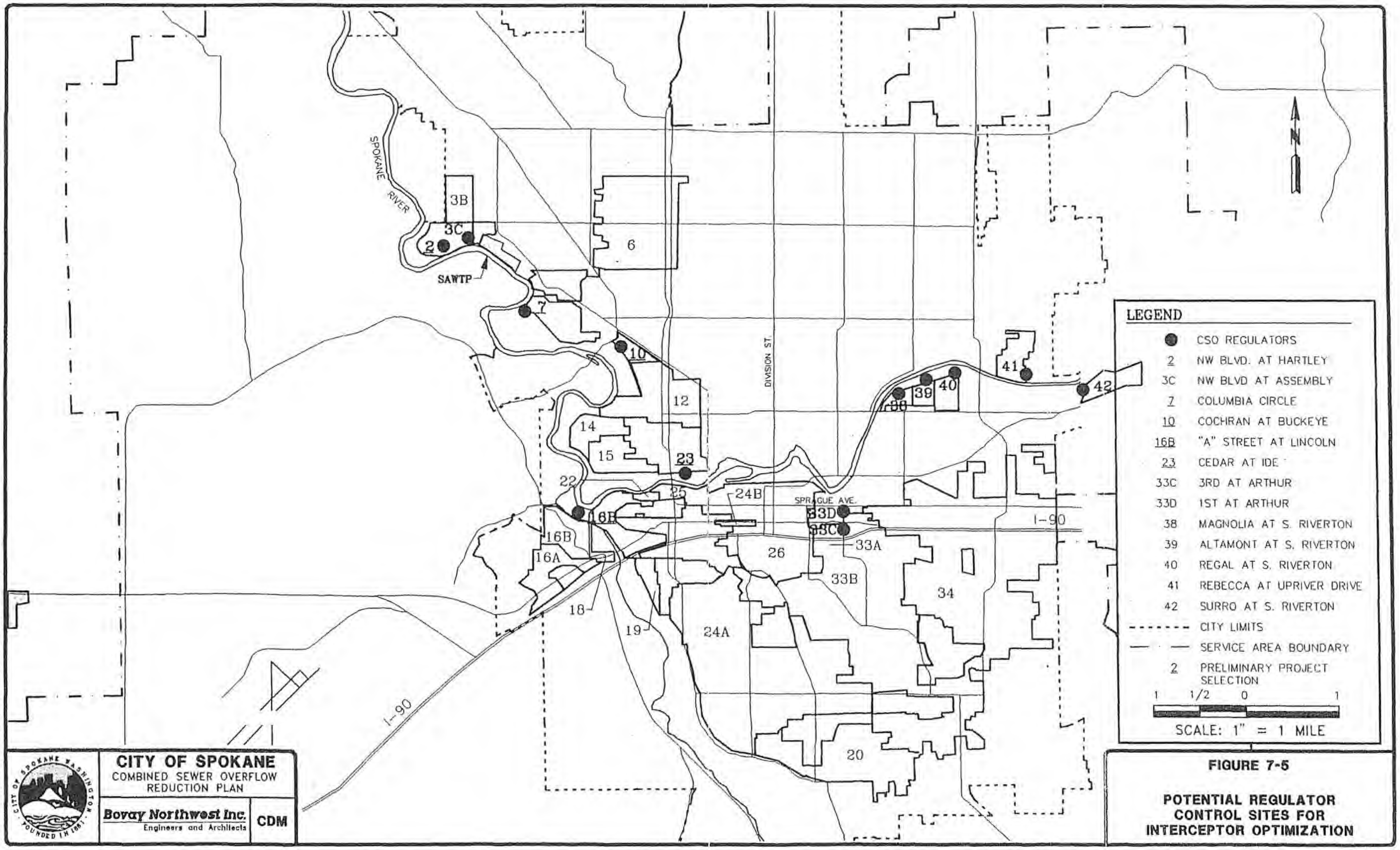

FIGURE 7-5

POTENTIAL REGULATOR CONTROL SITES FOR INTERCEPTOR OPTIMIZATION

TABLE 7-8. OPTIMIZED INTERCEPTOR AND PRIMARY TREATMENT CAPACITY OPTION

CSO No.	Reduction in Annual Volume (MG/Year[1])	Reduction Annual Frequency	Capital SAWTP Costs ($1,000)	Capital Interceptor Costs ($1,000)	Annual SAWTP[2] Treatment Costs ($1,000)	Total Costs ($1,000)
2	1.59	5	388	2	0.82	400
3B	0	1	0	0	0	0.00
3C	1.91	1	582	2	0.99	596
6	11.7	10	3,180	221	6.05	3,483
7	0.67	2	737	14	0.35	755
10	0.24	1	349	6	0.13	357
12	9.36	2	8,765	176	4.83	9,007
14	0.36	12	116	113	0.19	232
15	2	21	349	132	1.03	495
16A	0	0	0	0	0	0
16B	0.48	1	39	87	0.25	128
18	0		0	0	0	0
19	0		0	0	0	0
20	0	1	0	915	0	913
22	0		0	0	0	0
23	1.49	3	892	29	0.77	932
24A	1.24	1	1,202	25	0.64	1,235
24B[3]						
25	0.07	16	271	173	0.04	445
26	5.82	12	5,119	110	3.00	5,270
33A	0		0	0	0	0
33B	0		0		0	0
33C	0.09	2	155	3	0.05	159
33D	1.91	3	814	37	0.99	865
34	4.13	11	1,551	79	2.13	1,659
38	0.25	1	427	6	0.13	434
39	1.05	1	582	21	0.55	610
40	1.41	1	853	28	0.73	891
41	0.44	2	623	10	0.23	633
42	0.23	2	388	6	0.12	395
Totals	46.44		27,380	2,181	24.02	29,895

1. MG/year = Million Gallons per year
2. SAWTP = Spokane Advanced Wastewater Treatment Plan
3. Unknown overflow characteristics; probably low frequency/low volume.

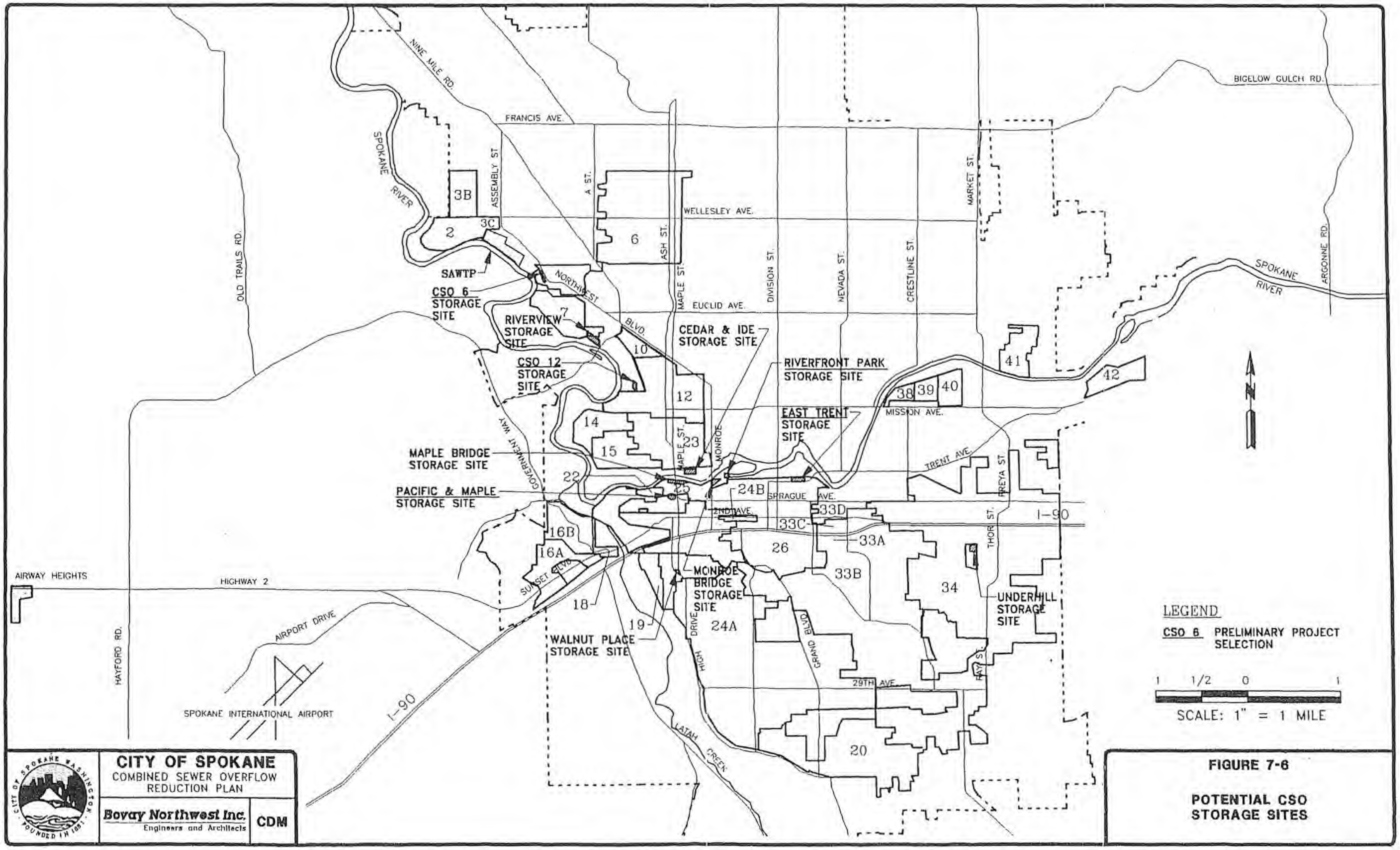

FIGURE 7-6

POTENTIAL CSO STORAGE SITES

Treatment of the stored volume of wastewater prior to release to the Spokane River is another cost that would be incurred with optimization-storage. The maintenance and operations costs shown in the tables within this section include treatment costs. The optimization-storage options discussed in this section were sized to release wastewater following the passage of peak flows. This allows utilization of existing hydraulic capacity at the treatment plant during off-peak hours of sanitary wastewater flow. However, it is possible that optimization-storage could require expanding the hydraulic capacity of the treatment plant. Additional study is required on the possibility of controlling storm water enough to eliminate the need for additional primary treatment capacity. If it is found that additional storm water capacity is needed, the engineering and construction cost of expanding primary capacity at the treatment plant must be done incrementally. The cost of two new primary clarifiers, assuming property is available at the existing SAWTP site, is approximately $7 million. There is very little room available at the existing SAWTP site, which will make planning and construction of this clarifier quite difficult.

7.3.2. Basin Optimization and Storage Analysis

Table 7-9 summarizes the important characteristics of the interceptor storage facilities. Each site is evaluated for in-line and off-line storage facilities. An in-line facility is a tank with a channel in the bottom which is part of the interceptor. Construction of in-line facilities costs slightly more than that for off-line facilities, but maintenance is less than for an off-line storage tank. Advantages of off-line storage are:

- There are options for the disposal of the effluent from the storage facility and as a result there are different control structures available

- Off-line storage allows more control of peak flow to the treatment plant.

Both in-line and off-line storage facilities would have flow control devices. The controls would prevent storm peaks from reaching the interceptor until non-peak, sanitary-only flows occurred. Control devices such as vortex valves would have a predetermined setting releasing flow from the in-line storage facility to the treatment plant.

Combined lines within the City interceptor system were analyzed for sufficient excess capacity to serve as storage for storm-event flows. These locations were determined using the SWMM simulations. However, the SWMM simulation indicated that there are no viable sections of interceptor with sufficient excess capacity. As a result, storage using the existing interceptor system pipes is not a viable alternative for the City.

TABLE 7-9. POTENTIAL STORAGE FACILITIES

Location	Description	Storage Capacity (MG)[2]	Annual Overflow Volume (MG)	Remaining Interceptor Flow (MGD)[3]	Total CSO Reduction (%)	Present Worth Capital Cost ($1,000)	Annual Maintenance Cost ($1,000)	Total Present Value[1] ($1,000)	Feasibility
CSO 6	Off Line	1.7	0.8	2.9	17	1,499	6.8	1,541	Steep Site. Use with Retention
CSO 6	In Line	1.7	0.8	2.9	17	1,653	0.78	1,662	
Riverview	Off Line	27.0	5.0	55.5	85	26,184	108.0	27,652	Requires Interceptor Modification
Riverview	In Line	27.0	5.0	55.5	85	29,424	10.8	29,571	
CSO 12	Off Line	1.0	0.5	3.8	12	671	4.0	725	Low Cost
CSO 12	In Line	1.0	0.5	3.8	12	791	0.4	796	
West Central	Off Line	1.5	0.8	5.8	18	1,217	6.0	1,298	Low Cost With Some Pipe
West Central	In Line	1.5	0.8	5.8	18	1,397	0.6	1,405	
Cedar @ Ide	Off Line	23.0	7.0	55.2	43	18,689	92.0	19,940	Requires Interceptor Modification
Cedar @ Ide	In Line	23.0	7.0	55.2	43	21,449	9.2	21,574	
Maple Bridge	Off Line	8.5	2.4	36.8	25	6,264	34.0	6,726	Requires Pumping
Maple Bridge	In Line	8.5	2.4	36.8	25	7,284	3.4	7,330	
Pacific & Maple	Off Line	0.95	1.0	12.7	1.4	573	3.4	619	Moderate Cost
Pacific & Maple	In Line	0.95	1.0	12.7	1.4	675	0.33	680	Moderate Cost
Walnut & 10th	Off Line	0.95	1.0	12.7	1.4	573	3.4	619	Small Site
Walnut & 10th	In Line	0.95	1.0	12.7	1.4	675	0.33	680	
Lincoln w/24[4]	Off Line	8.5	2.4	36.8	25	6,429	34.0	6,891	Some Pipe Required
Lincoln w/24	In Line	8.5	2.4	36.8	25	7,450	3.4	7,496	

TABLE 7-9. POTENTIAL STORAGE FACILITIES (cont.)

Location	Description	Storage Capacity (MG)[2]	Annual Overflow Volume (MG)	Remaining Interceptor Flow (MGD)[3]	Total CSO Reduction (%)	Present Worth Capital Cost ($1,000)	Annual Maintenance Cost ($1,000)	Total Present Value[1] ($1,000)	Feasibility
Lincoln w/o 24[5]	Off Line	5.0	1.3	36.8	24	4,032	20.0	4,304	Expensive Property
Lincoln w/o 24	In Line	5.0	1.3	36.8	24	4,632	2.0	4,659	
Riverfront w/o 24	Off Line	5.0	1.3	36.8	24	3,423	20.0	3,695	Moderate Cost
Riverfront w/o 24	In Line	5.0	1.3	36.8	24	4,023	2.0	4,050	
Riverfront w/24	Off Line	8.5	2.4	36.8	25	5,739	34.0	6,201	Some Pipe
Riverfront w/24	In Line	5.0	2.4	36.8	25	6,760	3.4	6,806	Some Pipe
East Trent	Off Line	8.5	3.0	34.4	20	6,836	34.0	7,298	Some Pipe Required
East Trent	In Line	8.5	3.0	34.4	20	7,856	3.4	7,902	
Underhill Park	Off Line	2.4	0.6	8.7	14	1,618	9.6	1,748	Moderate Cost
Underhill Park	In Line	2.4	0.6	8.7	14	1,906	1.0	1,919	

1. Total present value is the 1993 value including engineering, construction and annual costs using a 7 percent rate of return over 20 years.
2. MG = million gallons
3. mgd = million gallons per day
4. W/24 refers to the named facility with both CSO basins 24A and 26 contributing storm flow.
5. W/O 24 refers to the named facility with only CSO basin 26 contributing storm flow.

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Combining in-line storage with off-line storage was not modeled separately. The model storage was the gross storage required to reduce overflow frequency to the target level. At the time of a more detailed design, combined in-line and off-line storage can be evaluated.

CSO 2, Hartley and Northwest Boulevard: CSO regulator 2, with a leaping weir, could be opened enough to pass a 1-year storm to the interceptor. This is a preliminary strategy selection. There would not be any interceptor capacity modifications necessary. As shown in Table 7-7, the dynamic interceptor model indicates that hydraulic capacity at the wastewater treatment plant would not be affected significantly, since the increase in peak flow would be less than 1 mgd. There is no viable location for a storage site above the treatment plant that would serve this regulator.

CSO 3B, Albi Stadium: This basin meets the one event per year criteria.

CSO 3C, Royal Court: CSO regulator 3C, with a leaping weir, could be opened enough to pass a one-year storm to the interceptor. This is a preliminary strategy selection. There would not be any interceptor capacity modifications necessary. The dynamic interceptor model indicates that hydraulic capacity at the wastewater treatment plant would not be affected significantly, since the increase in peak flow would be less than 1 mgd. There is no viable location for a storage site above the treatment plant that would serve this regulator.

CSO 6, Kiernan and Northwest Boulevard: A storage facility at the Kiernan and Northwest regulator, CSO 6, could be located on the hillside south of and below Northwest Boulevard. See Figure 7-7 for the location of this preliminary strategy selection. The foundation work for this site would be difficult and expensive. This would be a relatively small facility storing only flow from CSO Basin 6. CSO regulator 6 would be replaced by the storage facility overflow regulator, which would utilize or replace the existing CSO outfall. This facility would not require a modification of the City's NPDES permit.

CSO 7, Columbia Circle: The existing regulator for CSO basin 7 is a leaping weir. The pipe from the regulator to the interceptor needs replacement because existing flows exceed capacity according to model analysis of the sewer system. Replacing the pipe and modifying the overflow structure to pass more flow to the interceptor would allow a reduction in overflow frequency at the weir. Implementation of this preliminary strategy selection would follow the reduction achieved using BMPs including on-site retention, as described in Section 7.2. The increased peak flow to the treatment plant may be as high as 1.2 mgd during a storm event.

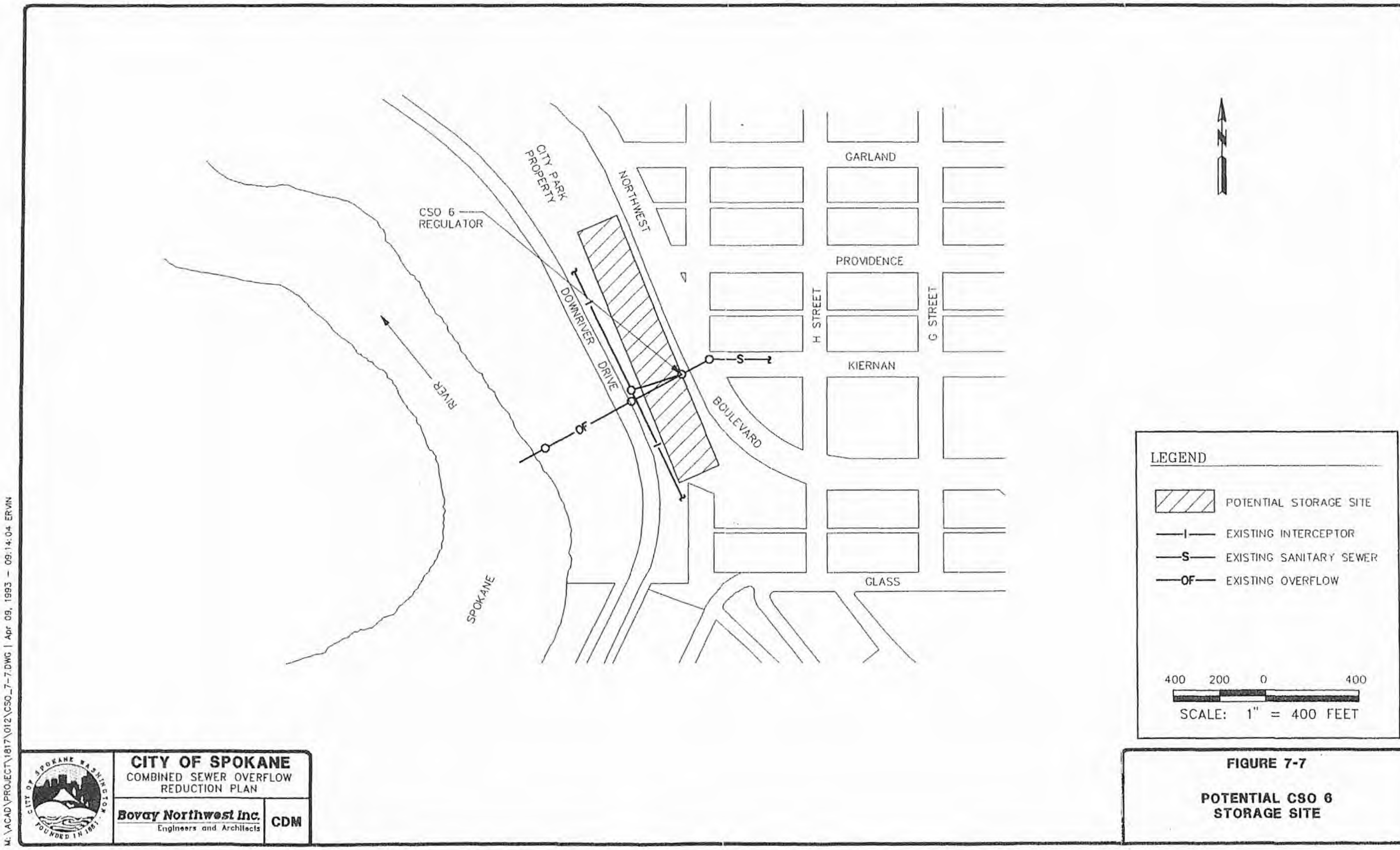

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FIGURE 7-7
POTENTIAL CSO 6 STORAGE SITE

Riverview: The Riverview Drive storage facility, hydraulically below the Meenach Drive inverted siphon and the discharge from the Cochran interceptor, would utilize the existing interceptor capacity in the lines above to carry storm flows. The possible location of this alternative is shown in Figure 7-8. Below the Riverview Drive storage facility the interceptor does not have sufficient capacity to handle additional flows. Construction of the Riverview Drive storage facility would take place on current City property, but there would still be a cost associated with land . Since it is located below a residential area, aesthetic considerations would be part of the facility design.

Overflow from this facility would be transmitted by pipe to an outfall adjacent to the existing storm water outfall below T.J. Meenach Bridge, possibly requiring an additional outfall designation on the City's NPDES permit. This large facility would reduce overflow to one event per year in all CSOs upstream of CSO 6. Table 7-10 shows how this storage facility affects the upstream CSOs. It was determined that this project would have a higher cost per volume of CSO reduction than other projects to reduce comparable volume from the same CSO regulators.

CSO 10, Buckeye: The existing regulator at CSO 10 is a leaping weir. Analysis indicates that modification of the regulator setting to allow only one overflow per year would not require an increase in downstream interceptor capacity. Model analysis indicates that peak flow to the interceptor would increase by as much as 0.6 mgd without the mitigation of flow reduction from implementing BMPs in the CSO 10 basin. Dynamic interceptor model analysis indicates that peak flow at the treatment plant would not increase measurably as a result of implementing the preliminary strategy selection of overflow structure modification at this site.

CSO 12, Nora and Pettet: Alternatively, a 1.0 MG facility could be constructed that would only store flow from CSO 12. However, a storage facility at Nora and Pettet could be located along Pettet Drive. See Figure 7-9. The preliminary strategy selection is a 1.5 MG storage facility that would store overflow from CSO 12, CSO 14 and CSO 15. Additional sewer capacity will be needed between CSO 14 and CSO 15 and between CSO 15 and the north river interceptor. A weir or valve would be needed in the north river interceptor near the storage facility to divert flow to the storage facility. CSO regulator 12 would be replaced by the storage facility overflow regulator, which would utilize or replace the existing CSO outfall. This facility would not require a modification of the SAWTP NPDES permit.

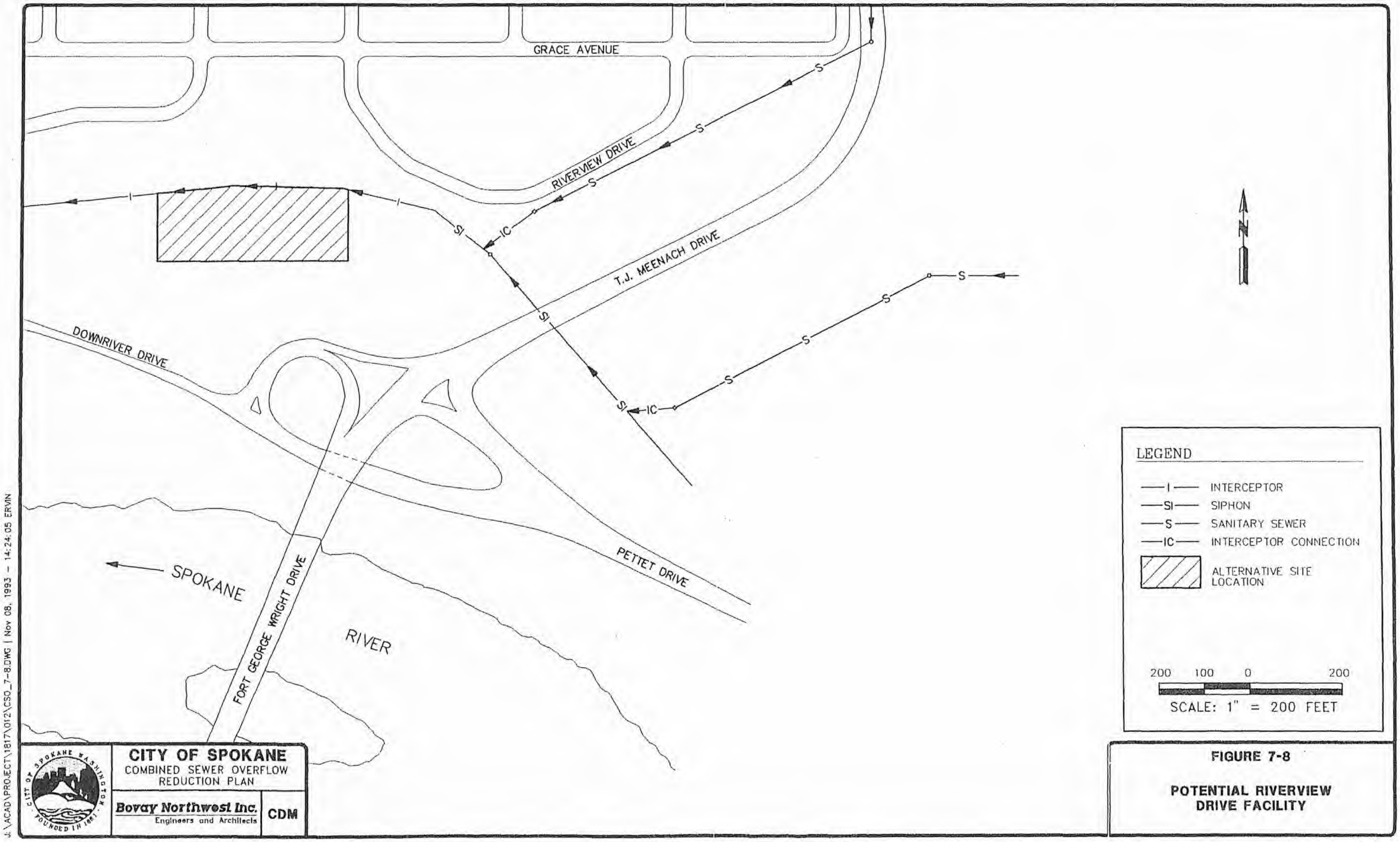

FIGURE 7-8

POTENTIAL RIVERVIEW DRIVE FACILITY

TABLE 7-10. CSO REDUCTION EFFECT OF CENTRAL STORAGE FACILITIES ON UPSTREAM CSOs[1]

	Storage @ Riverview			Storage @ Cedar & Ide			Storage @ East Trent		
Overflow Regulator	Storage (MG)[2]	In-Line ($1,000)	Off-Line ($1,000)	Storage (MG)	In-Line ($1,000)	Off-Line ($1,000)	Storage (MG)	In-Line ($1,000)	Off-Line ($1,000)
10	0.12	134	125						
12	4.37	4,785	4,474						
14	0.39	426	399						
15	2.02	2,216	2,073						
16A	0.00	5	5						
16B	0.23	250	234						
20	0.05	55	51	0.06	55	50			
23	0.77	838	784	0.89	838	774			
24A	0.96	1,051	983	1.12	1,051	971			
25	0.16	174	162	0.00	0	0			
26	8.93	9,783	9,148	10.42	9,779	9,038			
33B	1.04	1,140	1,066	1.22	1,140	1,054	0.98	914	894
33C	0.05	59	56	0.06	59	55	0.05	48	44
33D	0.92	1,007	941	1.07	1,006	930	0.87	807	745
34	5.33	5,841	5,462	6.22	5,838	5,398	5.04	4,682	4,324
38	0.13	139	130	0.15	139	128	0.12	111	103
39	0.48	526	491	0.56	525	486	0.45	421	389
40	0.66	719	672	0.77	719	664	0.62	576	532
41	0.24	258	241	0.27	258	238	0.22	207	191
42	0.14	154	144	0.16	154	142	0.13	123	114
Totals[3]	27.00	29,558	27,640	23.00	21,559	19,926	8.50	7,890	7,287

1. Storage and costs allocated by amount of overflow reduction at each affected CSO.
2. MG = million gallons
3. Numbers are rounded.

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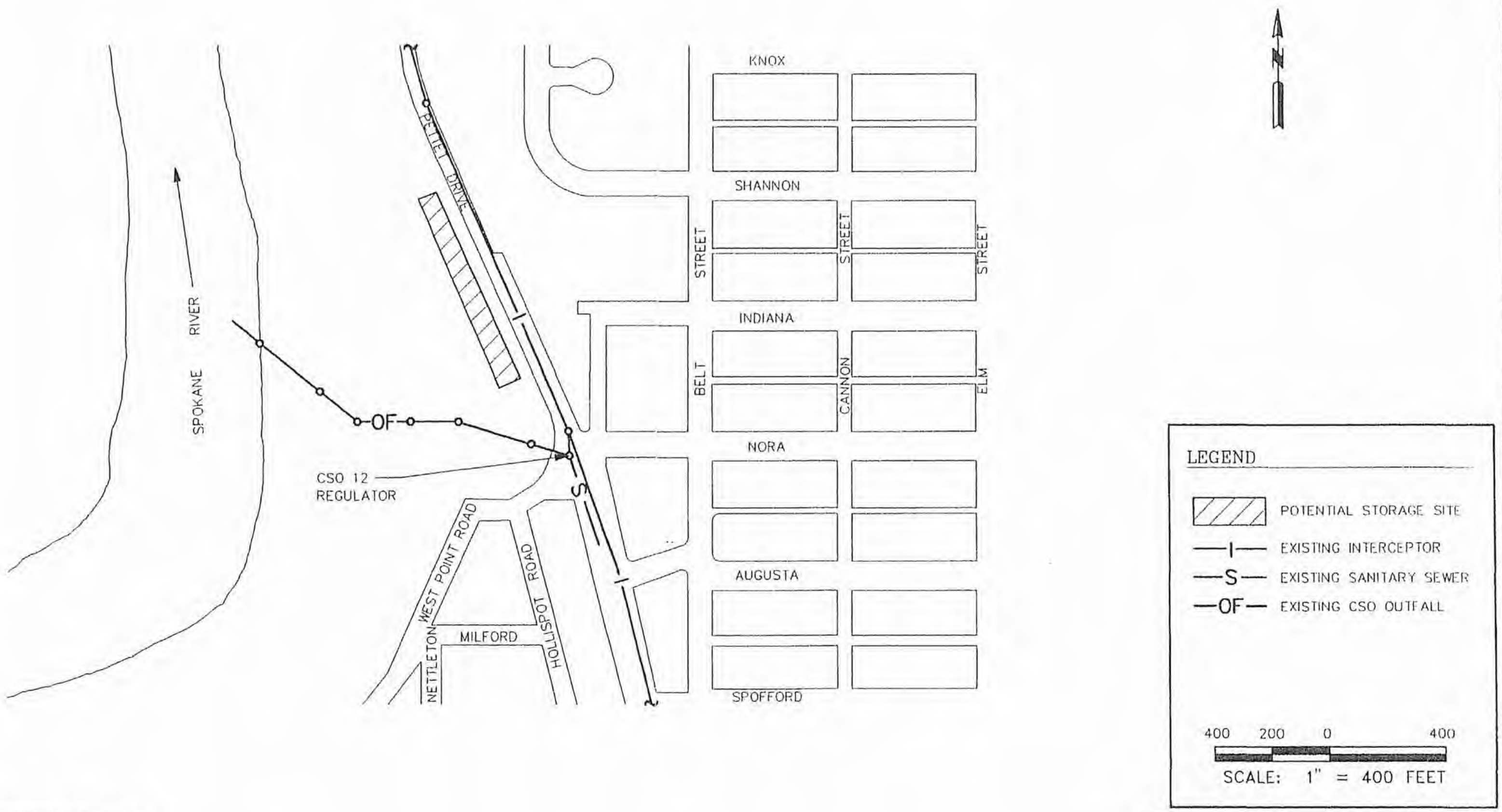

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FIGURE 7-9

POTENTIAL CSO 12 STORAGE SITE

CSO 14, Summit and Sherwood: This regulator's setting would be modified to pass all flow up to the magnitude of a one event per year flow. The trunk between this regulator and the regulator for CSO basin 15 at Nettleton and Ohio would be enlarged to accept this flow. The preliminary strategy selection mentioned for CSO 12, a storage facility near the intersection at Nora and Pettet, would be used to reduce the peak flows resulting from the increased flows from the CSO 14 basin's regulator.

CSO 15, Nettleton and Ohio: This regulator's setting would be modified to pass all flow up to the magnitude of a one event per year flow. The trunk between this regulator and the North River Interceptor at Chestnut and Bridge would be enlarged to accept this flow and the increased flow from CSO basin 14. The preliminary strategy selection mentioned for CSO 12, a storage facility near the intersection at Nora and Pettet, would be used to reduce the peak flows resulting from the increased flows from the CSO 15 basin's regulator.

CSO 16A, Geiger: This basin meets the one event per year criteria.

CSO 16B, West Grove: Modification of the leaping weir regulating structure at "A" and Linton serving the West Grove area would reduce overflow there to one event per year without requiring an increase in interceptor capacity. Peak flow to the interceptor would increase by as much as 1.0 mgd as a result of this preliminary strategy selection. This figure does not account for flow reductions due to the BMP programs in this basin outlined in Section 7.2. Dynamic model analysis indicates that there would not be an increase in peak flows at the treatment plant.

CSO 18, Federal Housing Authority: This basin meets the one event per year criteria.

CSO 19, Under Freeway Bridge: This basin meets the one event per year criteria.

CSO 20, West of High Drive, South of 33rd: The best management practices outlined in Section 7.2, including completing separation, will be sufficient to reduce overflow frequency at this regulator to less than one event per year.

CSO 22, Oak at Main: This basin meets the one event per year criteria.

CSO 23, Cedar & Ide: A storage facility could be located at the abandoned railroad right-of-way just west of Cedar Street and south of Bridge Avenue. See Figure 7-10. This site is located along the north river bridge interceptor immediately downstream of the CSO regulator 23 discharge into the interceptor. A limitation of the site is that site soil could be contaminated due to the history of on-site railroad activity. The property is currently privately owned by a development company, but an agreement might be reached to make this a multi-use facility putting tennis courts or other park-like facilities on top of the storage facility.

The overflow from a Cedar and Ide storage facility would share the outfall from CSO 23, so that a separate CSO outfall designation on the City NPDES permit would not be necessary. The large facility would enable reduction of overflow frequency to one event per year for all the CSOs upstream of CSO 23. See Table 7-10 for details of the effect on upstream CSOs. This facility was found to have a high cost per gallon of CSO volume reduction.

The preliminary strategy selection for CSO 23 is to modify the regulator setting to one event per year following implementation of the BMP strategies outlined in Section 7.2. Model results indicate that overflow frequency at this leaping weir regulator may be reduced to three events per year by modifying the overflow structure and optimization of existing interceptor capacity. An increase in capacity of the line between the regulating structure and the north river bridge interceptor is required under existing conditions. The increase in peak flow to the interceptor would be as high as 1.5 mgd. Dynamic model analysis indicates that peak flow at the treatment plant would not increase.

CSO 24A, Cedar at Riverside, South Hill Basin: There are several options available for optimization and storage of flows passing CSO regulator 24A. These options are storage-oriented, including storage at Maple Bridge, Pacific and Maple and Walnut Place. Other options include combining storage with CSO 26. The Maple Bridge storage facility would also take flows from CSO regulator 26.

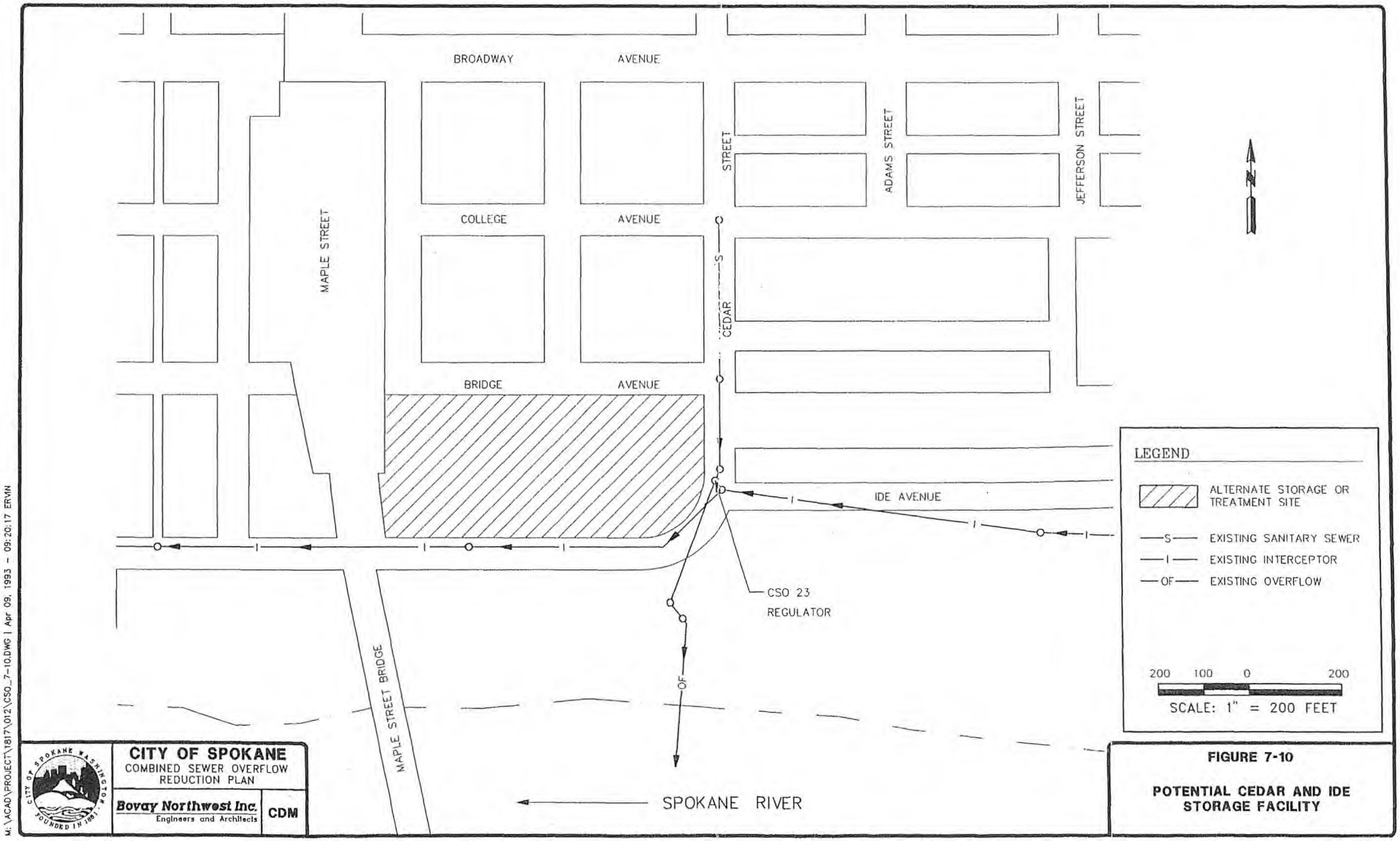

FIGURE 7-10

POTENTIAL CEDAR AND IDE STORAGE FACILITY

Maple Bridge: A storage structure could be located at the park at the footing of the south pylon supporting the Maple Bridge, as shown in Figure 7-11. The existing overflow line from CSO regulator 24A would continue to bring CSO down to the Park, and a new overflow line would carry flow from CSO regulator 26 to the Maple Bridge park site storage facility. A new interceptor line would then take the attenuated flow to a new Elm street pump station, which would pump flow up to the Clarke Avenue pump station, also with additional capacity, from which flow would be pumped up to the north river interceptor on the north bank of the Spokane River at the existing location. Table 7-11 shows how this and other west South Hill storage alternatives would affect CSO regulators 20, 24A and 26.

Schematic representations of in-line and off-line storage between CSO regulators 24A and 26 are shown in Figures 7-12 and 7-13, respectively.

Pacific & Maple: This storage structure, the basis of the preliminary strategy selection for CSO basin 24A, would be located at the south end of the Maple Street Bridge (see Figure 7-14). This facility would reduce the CSO overflow in the South Hill area to one event per year. CSO 24A volume and frequency would be affected as shown in Table 7-7. The property is owned by the City and construction would be relatively easy compared with the other sites near downtown. See Table 7-11 for details.

Walnut Place: Two combined sewers merge at Walnut and 10th Avenue as shown in Figure 7-15. Overflow from CSO 24A would be collected at this site. Since this is not located near the river, an overflow line would be constructed to the existing overflow for CSO 24A, making this strategy more expensive than the construction of Storage at Maple and Pacific. This is a relatively narrow site, therefore an in-line facility would be the best choice at this location. See Table 7-11 for details.

CSO 24B, Cedar and Riverside, Second Avenue Basin: This basin is approximately 20 acres, primarily along Second Avenue east of Cedar Street. The regulator was located during preparation of this Plan; as a result no model analysis has been done for this basin. However, it is unlikely to overflow frequently because the side overflow is eight inches above the influent pipe invert, and within five linear feet downstream of the side overflow point is a nine-inch high dam that must be overtopped prior to overflow reaching the Spokane River.

CSO 25, Cedar at Main: The best management practices outlined in Section 7.2 for this CSO basin, including retention storage and separation, will be sufficient to reduce overflow frequency at this regulator to less than one event per year.

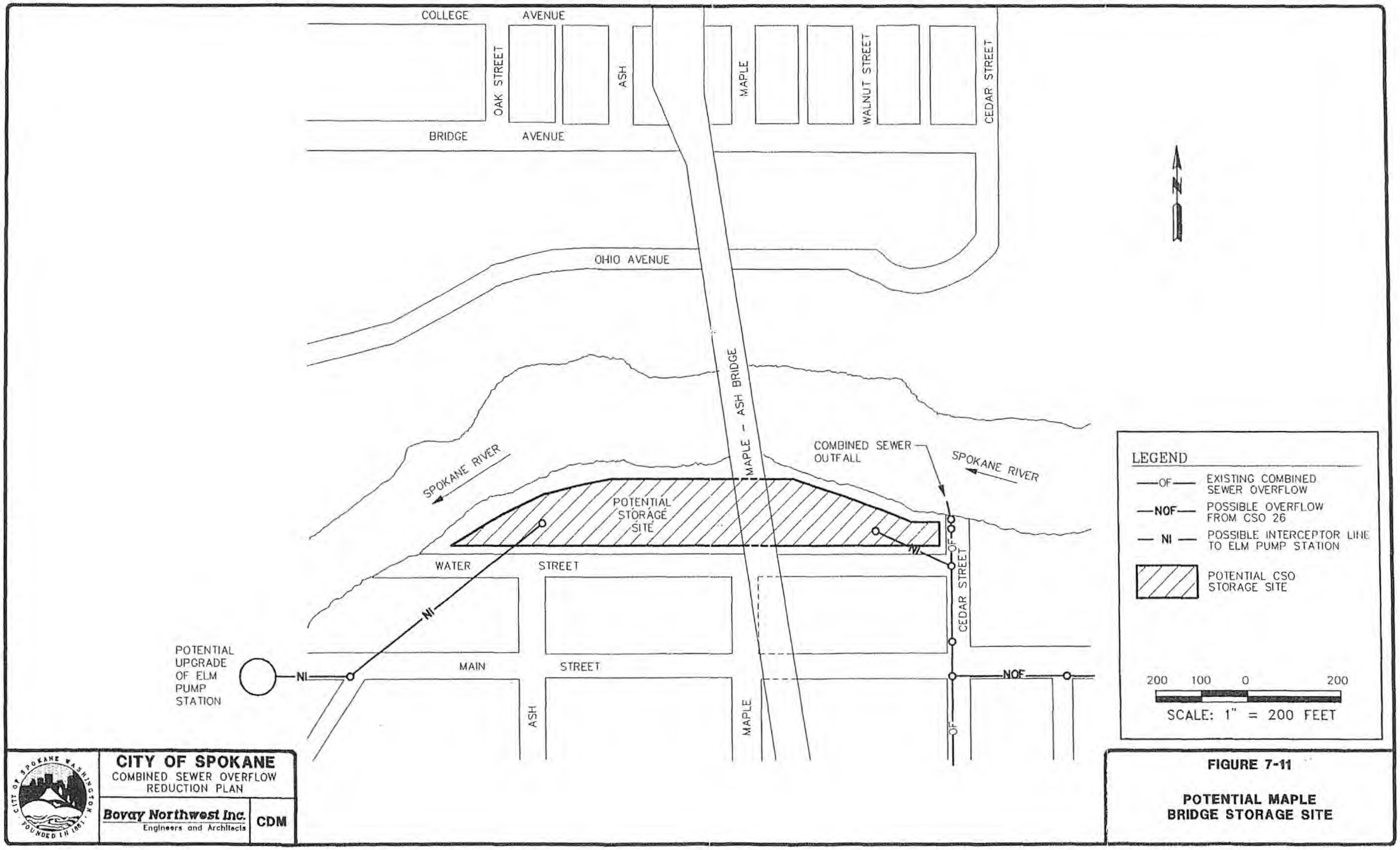

FIGURE 7-11

POTENTIAL MAPLE BRIDGE STORAGE SITE

TABLE 7-11. WEST SOUTH HILL STORAGE FACILITIES
DISTRIBUTION OF STORAGE AND COSTS[1]

Storage Location	Included Regulators	Storage Capacity (MG)[2]	In-Line Costs ($1,000)	Off-Line Costs ($1,000)
CSO #26 only				
Riverfront Park		5.00	4,050	3,695
Lincoln & Spokane Falls		5.00	4,659	4,304
CSOs #24A & 20				
10th & Walnut	Total	0.85	680	619
	20	0.04	34	31
	24A	0.81	646	588
Maple & Pacific	Total	0.85	680	619
	20	0.04	34	31
	24A	0.81	646	588
CSOs #26, 24, & 20				
Riverfront Park	Total	8.50	6,805	6,201
	20	0.04	34	31
	24A	0.82	656	598
	26	7.64	6,115	5,572
Lincoln & Spokane Falls	Total	8.50	7,495	6,891
	20	0.04	38	35
	24A	0.82	723	665
	26	7.64	6,735	6,192
Maple Street Bridge	Total	8.50	7,330	6,726
	20	0.04	37	34
	24A	0.82	707	649
	26	7.64	6,586	6,043

1. Storage and costs allocated by amount of overflow reduction at each effected CSO.
2. MG = million gallons

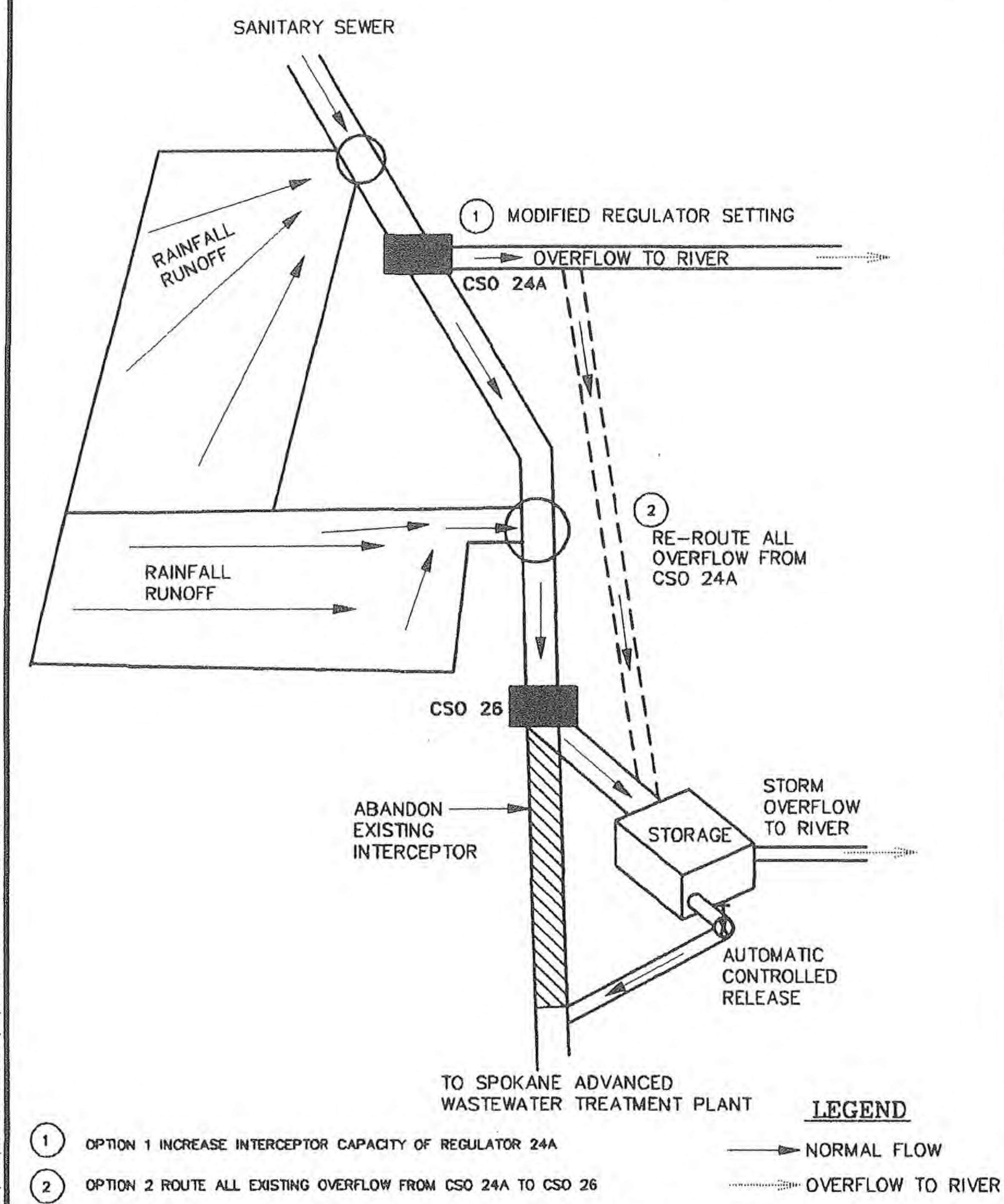

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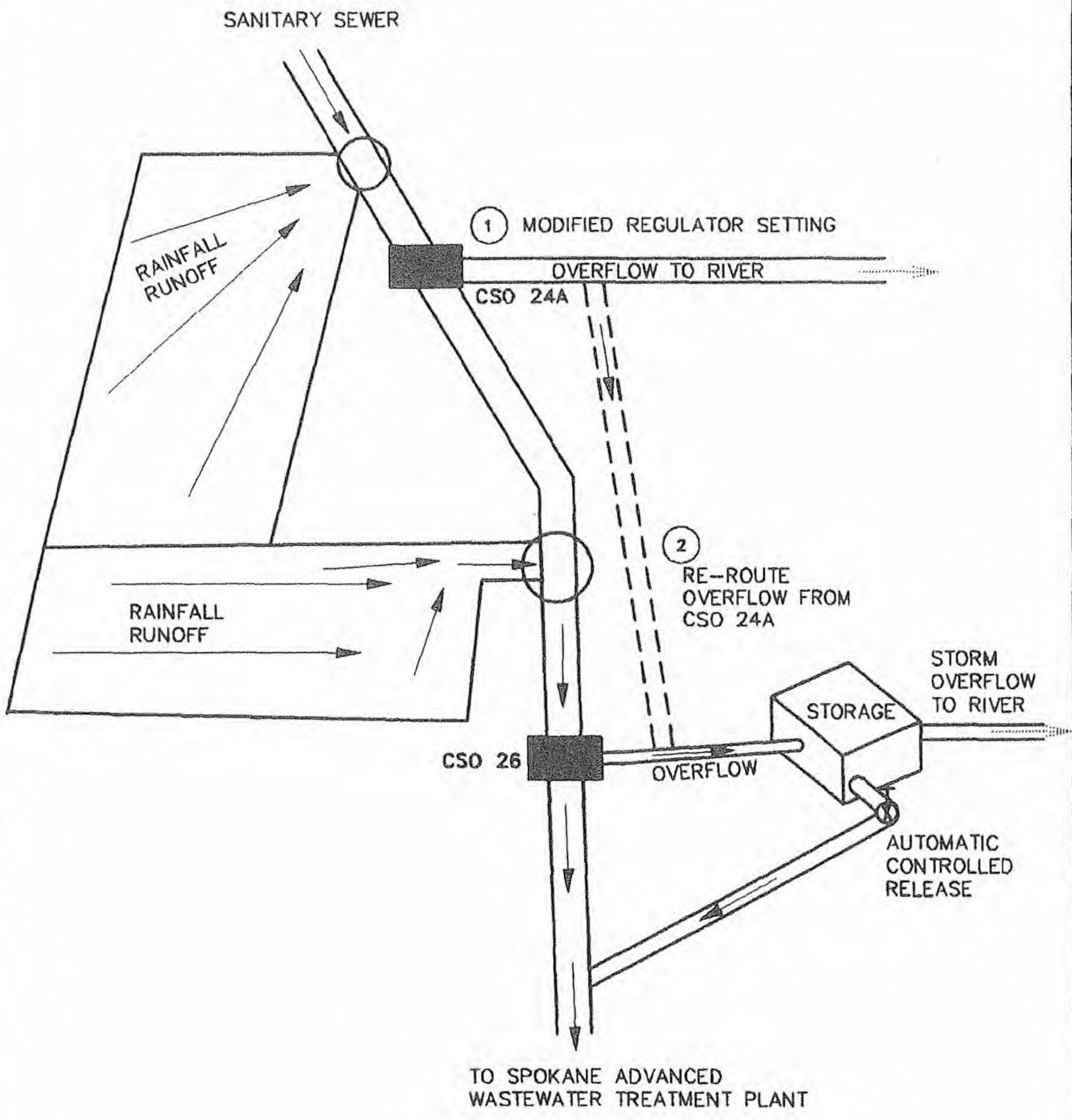
FIGURE 7-12

IN-LINE STORAGE SCHEMATIC FOR CSOS 24A AND 26



1 OPTION 1 INCREASE INTERCEPTOR CAPACITY OF REGULATOR 24A

2 OPTION 2 ROUTE ALL EXISTING OVERFLOW FROM CSO 24A TO CSO 26

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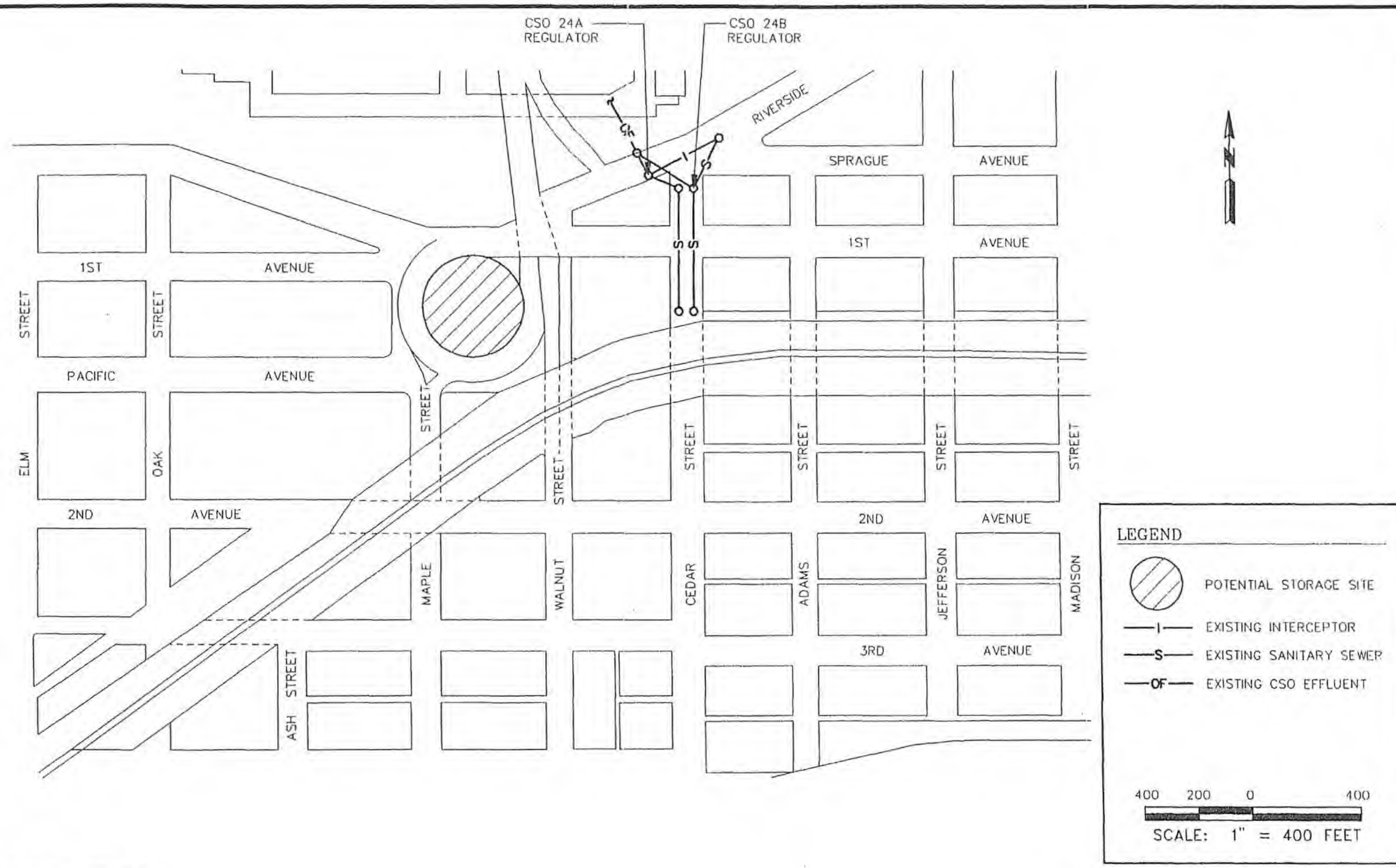
CITY OF SPOKANE WASHINGTON FOUNDED IN 1881	**CITY OF SPOKANE** COMBINED SEWER OVERFLOW REDUCTION PLAN *Bovay Northwest Inc.* Engineers and Architects — CDM	**FIGURE 7-13** **OFF-LINE STORAGE SCHEMATIC FOR CSOS 24A AND 26**



CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN

Bovay Northwest Inc. Engineers and Architects | CDM

FIGURE 7-14

POTENTIAL PACIFIC AND MAPLE STORAGE SITE

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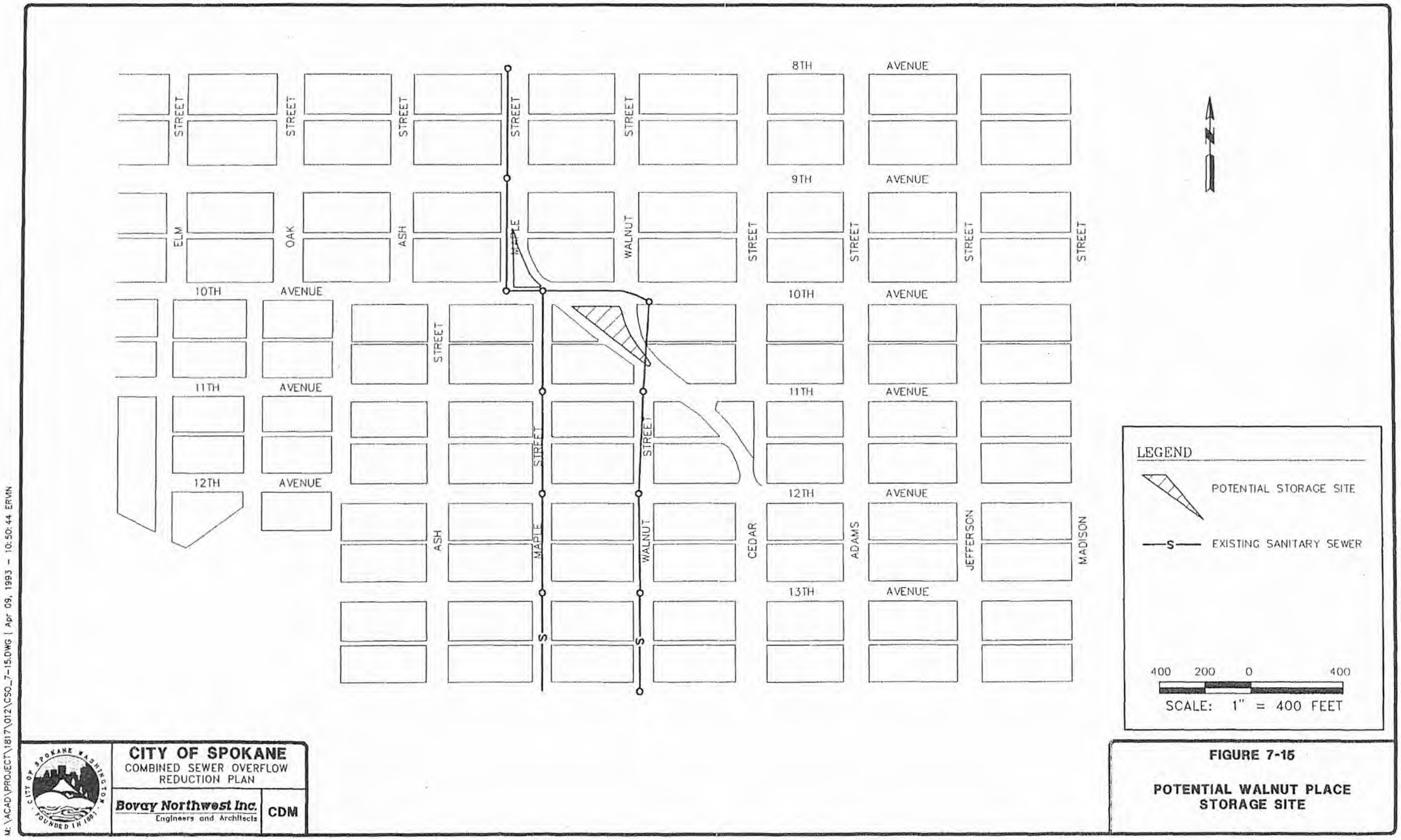

FIGURE 7-15

POTENTIAL WALNUT PLACE STORAGE SITE

CSO 26, Lincoln at Spokane Falls: Several storage options were developed to store storm water flows from CSO 26. The cost of these options, as well as separation, detention storage and retention are compared in Figure 7-16.

Lincoln Storage Site: An 8.5 MG storage facility at Lincoln and Spokane Falls would collect overflow routed from the Cedar and Riverside overflow No. 24A and from the Lincoln and Spokane Falls overflow No. 26. A smaller 5 MG facility would collect overflow only from CSO regulator 26. The facility would be located on the steep fill area north of Spokane Falls and immediately east of the Monroe Bridge, as shown in Figure 7-17. The property is privately owned and may be expensive to purchase. Construction of this facility would require expensive foundation work. Since this facility would be located adjacent to the downtown area, aesthetics would be of high importance as well as technical practicality. See Table 7-11 for details on the cost of this facility.

Riverfront Park: Another potential storage facility serving the downtown combined sewer area could be located in Riverfront Park, as shown in Figure 7-17. For in-line storage, the south river interceptor would be re-routed through the park and through the storage facility before flow would cross the Post Street bridge or a replacement structure. Two different sized facilities were evaluated, similar to the Lincoln site. The smaller, 5-MG facility is a preliminary strategy selection. However, basalt outcrops and abandoned utilities dating from the time when the park was owned by the railroad could complicate and increase the costs of the project. It would also be difficult to schedule construction around the many annual festivals held in the park during the time of year when construction would take place. See Table 7-11 for details on the cost of this facility.

East Trent Site: An in-line storage facility may be located along Trent Avenue near Pine Street, as shown in Figure 7-18. This facility would attenuate flows in the south river interceptor from all of the CSO 33 basins, as well as CSO basins 34, 38, 39, 40, 41, and 42. Analysis indicates that existing interceptor capacity is sufficient, except as noted below for CSO 34. See Table 7-10 for details of how this preliminary strategy selection would affect regulator volume and frequency. The site has an existing concrete ditch that was once used as part of a railroad switching yard. The state is currently storing contaminated soil in the bottom of this "ditch" and plans to build an underground parking structure in 40 years. As an alternative, the adjacent parking lot to the north could be used for underground parking or underground storage. Utilizing this site would mean construction of an additional CSO outfall, which would be required to be included in the City NPDES permit.

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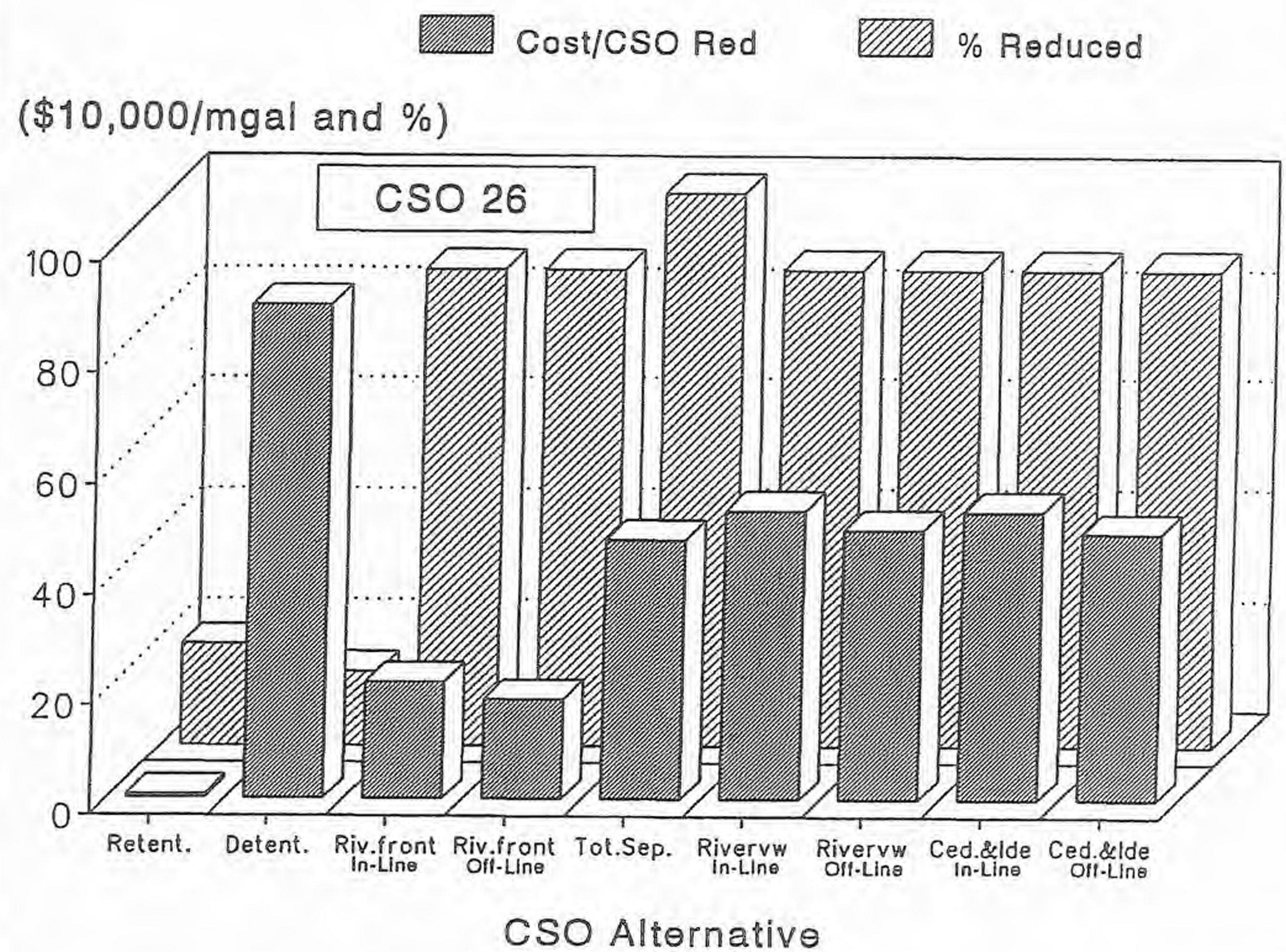

CITY OF SPOKANE
WASTEWATER FACILITIES PLAN

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FIGURE 7-16

CSO 26 COST COMPARISON

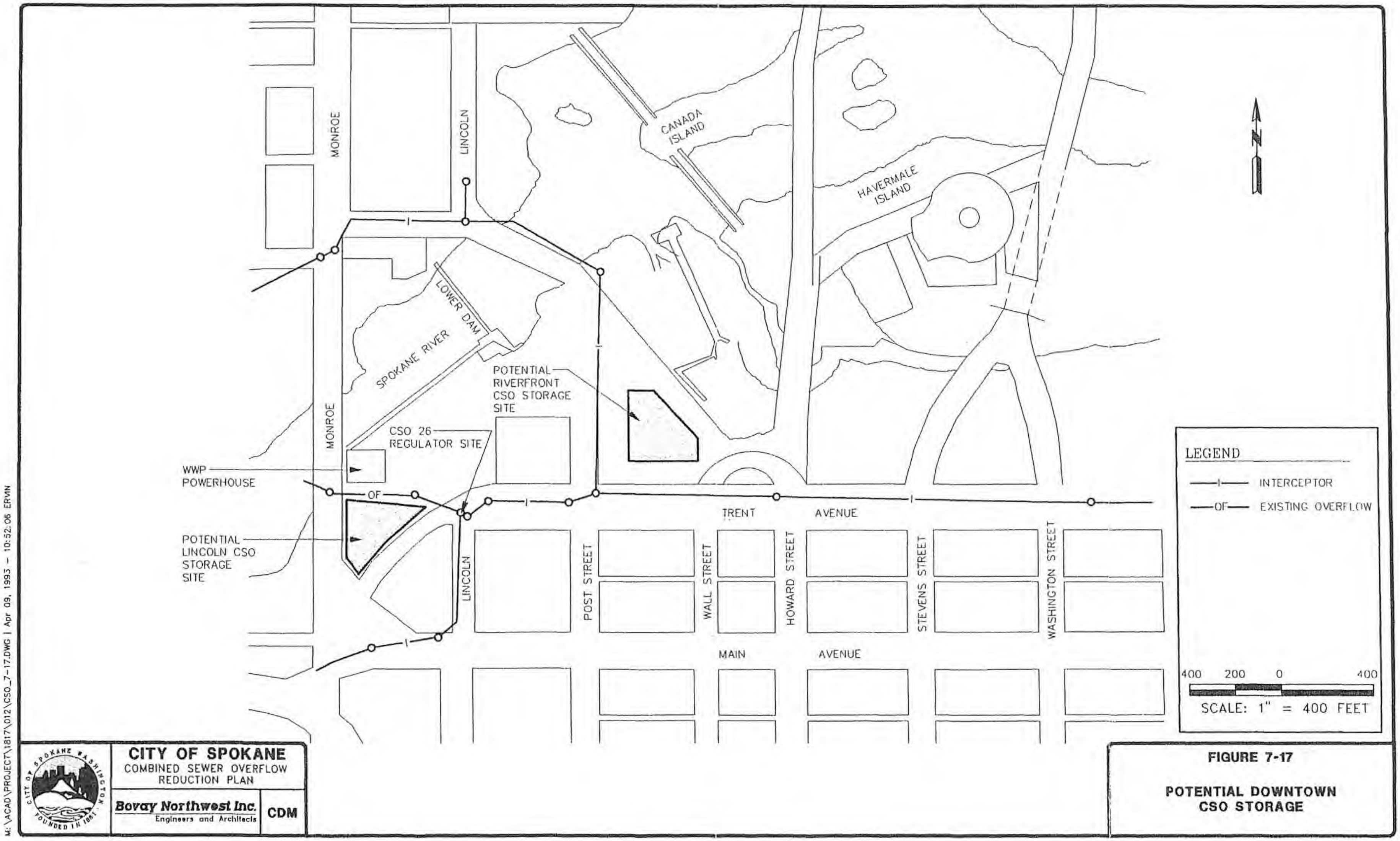
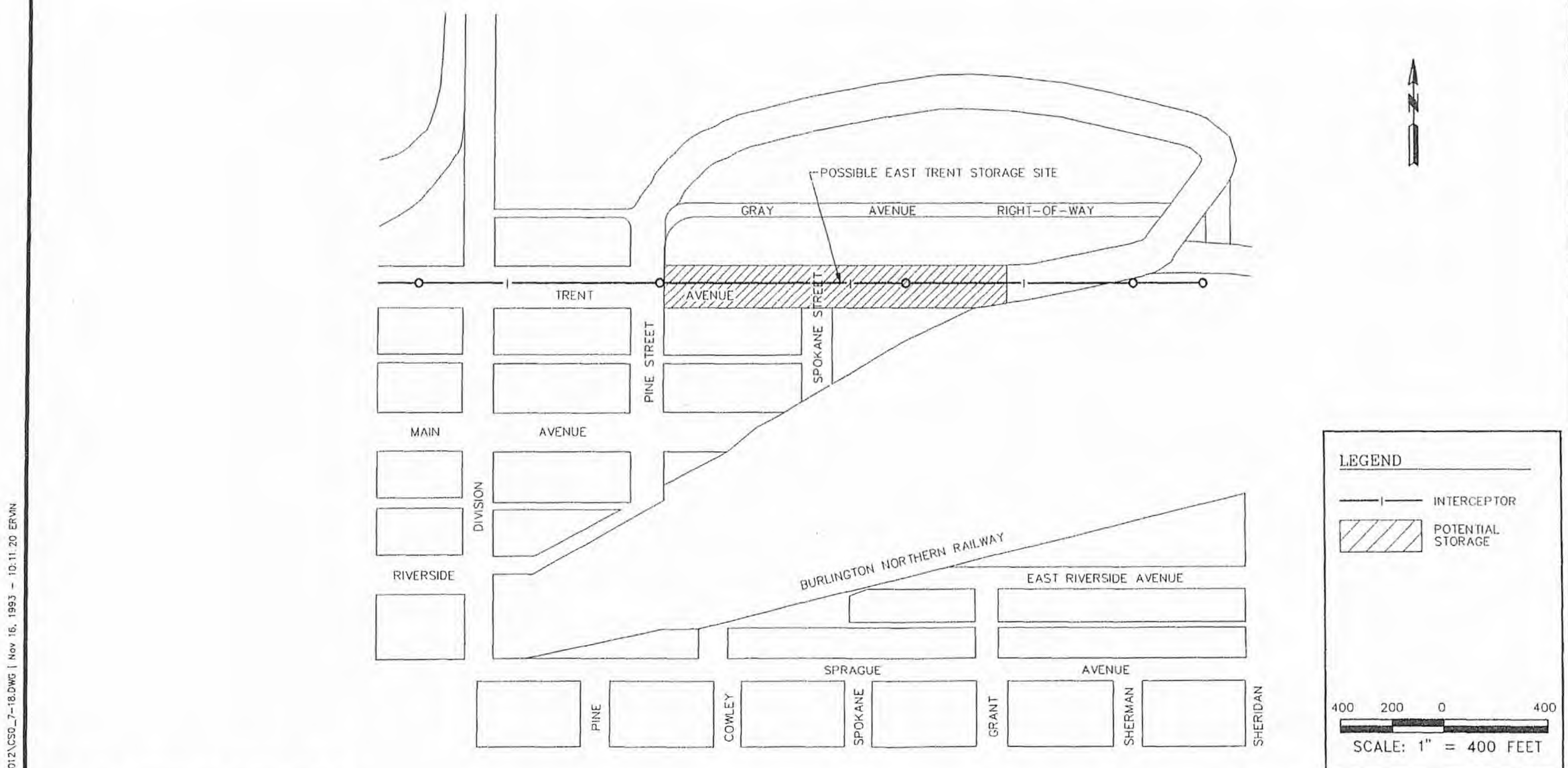


FIGURE 7-17

POTENTIAL DOWNTOWN CSO STORAGE



CITY OF SPOKANE
COMBINED SEWER OVERFLOW REDUCTION PLAN
Bovay Northwest Inc. Engineers and Architects
CDM

FIGURE 7-18

POTENTIAL EAST TRENT STORAGE FACILITY

CSO 33A, Fifth at Arthur: This basin meets the one event per year criteria.

CSO 33B, Third at Perry: The regulator for CSO basin 33B may be adjusted to overflow once per year, with storm flows from this basin and others along the south river interceptor diverted into the East Trent storage facility, which is the preliminary strategy selection for this CSO regulator and basin.

CSO 33C, Third at Arthur: The existing regulator at the corner of Arthur Street and Third Avenue, CSO 33C, is a leaping weir. A replacement regulator may be adjusted to reduce CSO to one overflow per year with peak flow reduction provided by on-site detention, as described in Section 7.2. There is enough capacity in the intercepting pipe downstream of CSO regulator 33B to handle additional flow from CSO regulator 33C. Peak flow to the interceptor system would be increased by 0.3 mgd. Due to the high cost of treating peak storm flows at SAWTP, storage of CSO 33C overflow at the East Trent site was found to have a lower cost per gallon of CSO volume reduction than only readjusting the regulator at CSO 33C and allowing flow to reach the treatment plant.

CSO 33D, First at Arthur: CSO regulator 33D, a leaping weir, is located on the west side of the south abutment of the Hamilton Street Bridge. Optimization of this structure to one event per year would also require on-site detention, as described in Section 7.2. Analysis indicates that peak flow to the interceptor would be increased by 1.4 mgd. Storage of CSO 33D overflow at the East Trent storage facility with weir modification was found to be more cost effective for control than only readjustment of the CSO 33D regulator due to the high cost of treating peak storm flows at SAWTP.

CSO 34, Between Napa and Crestline on Riverside: The potential Underhill Playground storage facility would be located under the north end of the playground, adjacent to Hartson Avenue. See Figure 7-19. For in-line storage, flow would be rerouted from the Southeast Spokane interceptor through the facility, which would provide storage for 891 acres of combined sewer area runoff. Control of this facility would be similar to that described for the Lincoln and Spokane Falls storage facility. This facility would reduce overflow frequency and volume at CSO regulator 34 to one event per year following implementation of BMP strategies listed in Section 7.2.
Storage of CSO basin 34 storm flow at the East Trent storage facility was found to be more cost effective than Underhill Park storage facility. This would require an increase in capacity below the existing CSO 34 regulator to the pipe junction with the south river interceptor. Construction of an overflow chamber with a regulator set to overflow once per year at Front and Erie would be constructed, utilizing the existing 60-inch overflow discharge pipe to convey combined flow to the regulator.

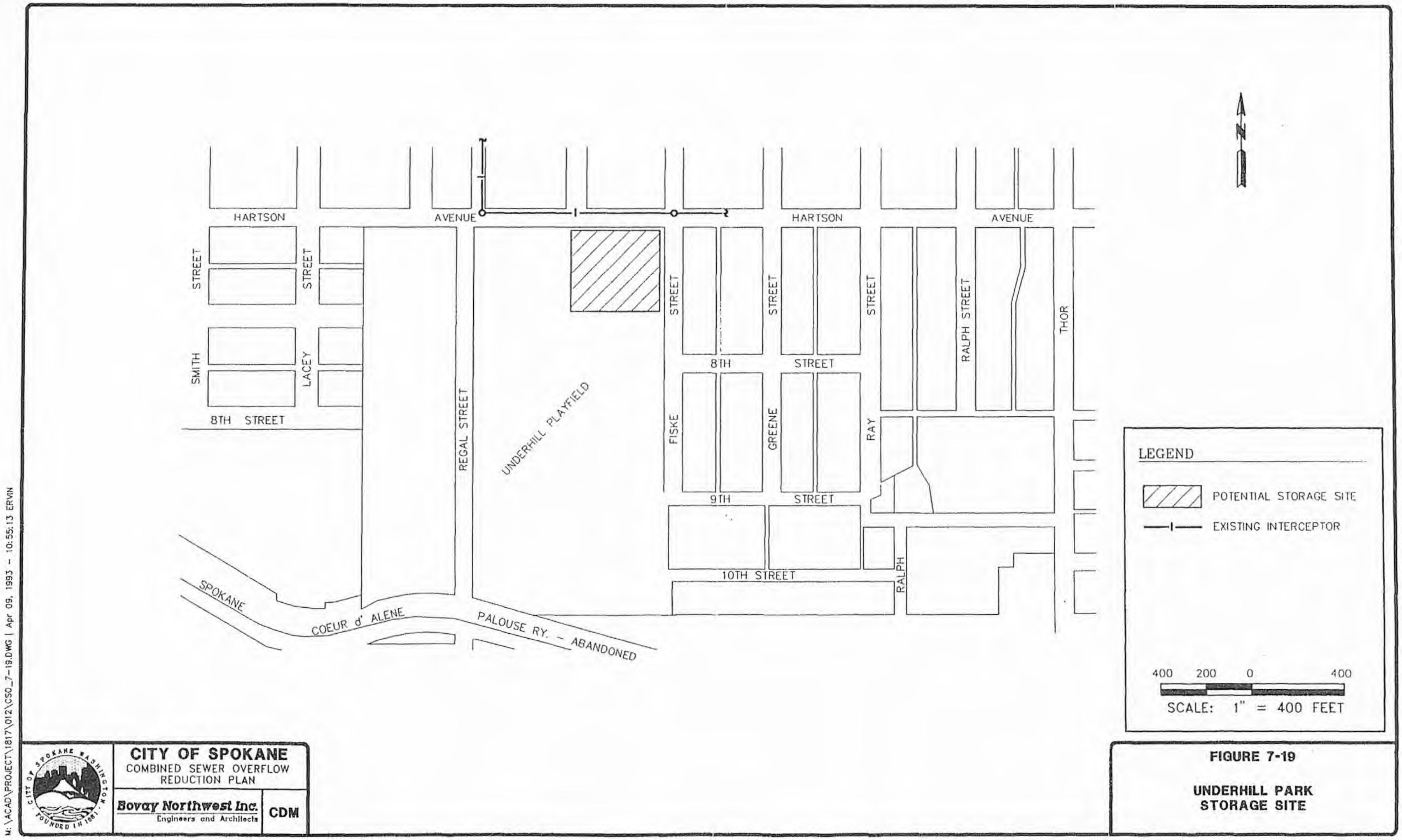


FIGURE 7-19

UNDERHILL PARK STORAGE SITE

CSO 38, South Riverton at Magnolia: The Magnolia and South Riverton overflow structure, CSO 38, is located just above the South River Interceptor. There is enough capacity in the interceptor to reduce CSO 38 to a 1-event per year level by opening the leaping weir sufficiently to pass the additional flow. CSO 38 overflows 10 times per year at an annual volume of under 300,000 gallons. However, storage of CSO basin 38 storm flow at the East Trent storage facility following implementation of the BMP strategies listed in Section 7.2 was found to be the most cost effective alternative for the basins upstream, and is therefore the preliminary strategy selection for this basin. The overflow structure would be modified and overflow diverted at the East Trent site at sufficiently high flows.

CSO 39, South Riverton at Altamont: In addition to CSO 38, CSO regulator 39 could be opened enough to reduce overflow to one event per year without surcharging the South River interceptor. As with CSO 38, though, storage of CSO basin 39 storm flow at the East Trent storage facility following implementation of the BMP strategies listed in Section 7.2 was found to be the most cost effective alternative, and is therefore part of the preliminary strategy selection for this basin.

CSO 40, South Riverton at Regal: In addition to CSOs 38 and 39, CSO regulator 40 could be opened enough to reduce overflow to one event per year without surcharging the South River interceptor. as with CSO basins 38 and 39 though, storage of CSO basin 40 storm flow at the East Trent storage facility following implementation of the BMP strategies listed in Section 7.2 was found to be the most cost effective alternative, and is therefore part of the preliminary strategy selection for this basin.

CSO 41, Upriver Drive at Rebecca: With flow reduction using on-site controls described in Section 7.1, the regulator at Upriver Drive and Rebecca, CSO 41, may be opened to reduce frequency to one event per year. Storage of CSO basin 41 storm flow at the East Trent storage facility following implementation of the BMP strategies listed in Section 7.2 was found to be a more cost effective alternative than allowing flows to reach the wastewater treatment plant, and is therefore part of the preliminary strategy selection for this basin.

CSO 42, South Riverton at Surro: With flow reduction using on-site controls described in Section 7.1, the regulator at Surro and South Riverton, CSO 42, may be opened to reduce frequency to one event per year. Storage of CSO basin 42 storm flow at the East Trent storage facility following implementation of the BMP strategies listed in Section 7.2 was found to be the most cost effective alternative, and is therefore the preliminary strategy selection for this basin. Frequency reduction by increasing flow from CSO regulator 42 would worsen the existing capacity bottleneck at manhole 05085, two manholes downstream of the CSO 42 discharge to the interceptor system. To alleviate the bottleneck and accommodate additional discharge from CSO 42, 6,342 feet of 15-inch and 18-inch south river interceptor pipe needs replacement with 21-inch pipe from Greene Street to Surro.

7.4 REMOTE SITE PRIMARY TREATMENT STRATEGY OPTION

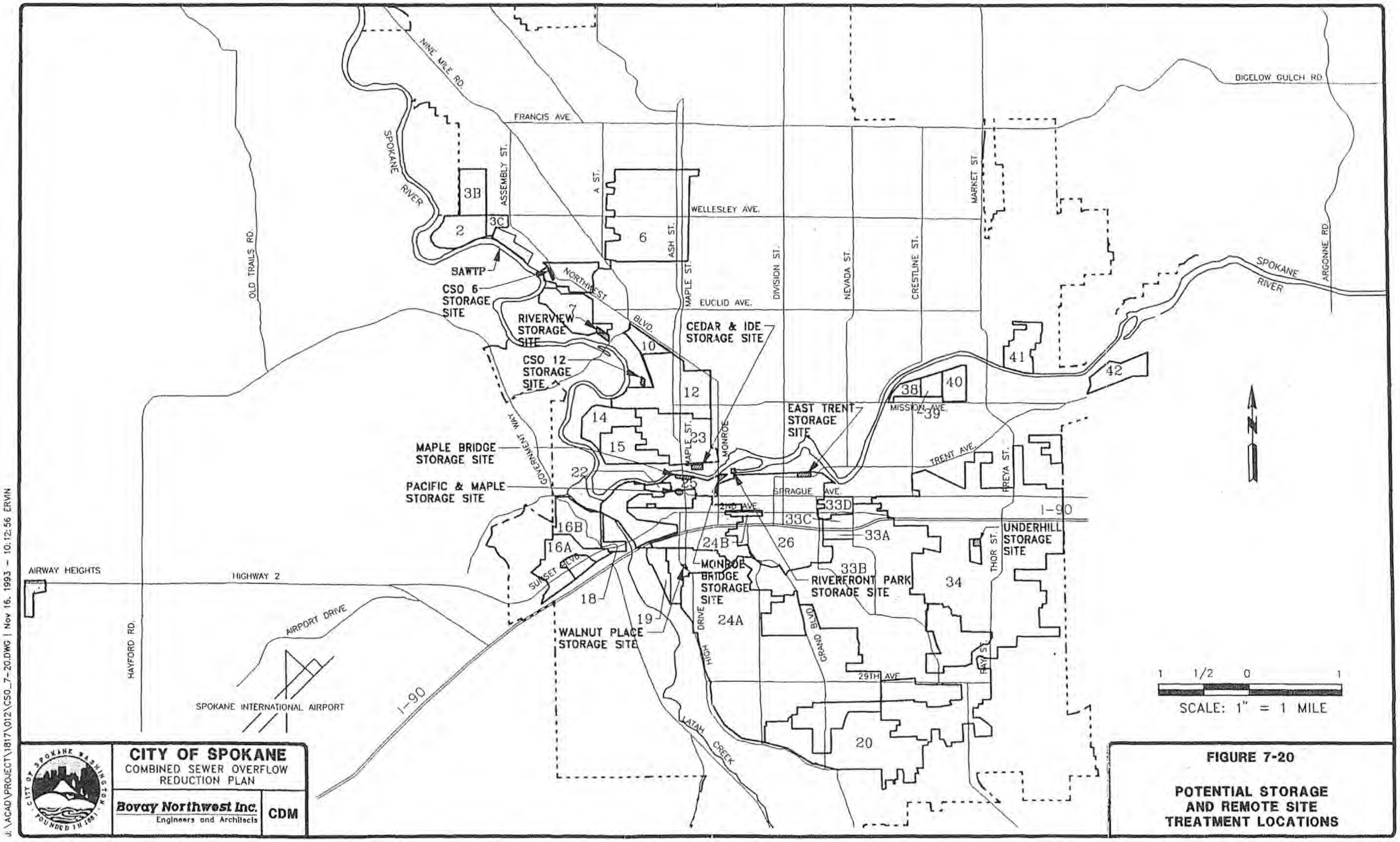
All remote site primary treatment alternatives would return concentrated wastewater to the SAWTP. All alternatives would entail a higher overall operation and maintenance cost to the city. The regulations regarding effluent water quality from primary-treated CSO are not clear, making their use at this time a potential regulatory problem for the City and Ecology.

The requirement in WAC 173-245-020, *Definitions*, is for primary treatment to accomplish "at least fifty percent removal of the total suspended solids from the waste stream, and discharges less than 0.3 ml/l/hr. [sic] of settleable solids". There is no language covering other waste water parameters, such as five-day biological oxygen demand, fecal coliform count, or phosphorus or other nutrient concentrations.

The requirement in WAC 173-245-040, *CSO Reduction Plan*, is for analysis of primary treatment alternatives to include adequately offshore submerged discharge. It is beyond the scope of this Plan to assess the mixing zone and diffusion requirements for off-shore discharges for each of the possible locations for remote site primary treatment.

If the regulatory guidelines covering primary treatment of CSO are clarified in the future, prior to completion of the BMP strategies presented in Section 7.2 and the final planning for control of the remaining CSO, then remote site primary treatment could be used in conjunction with the storage facilities selected in Section 7.3 as preliminary strategies. These sites are shown in Figure 7-20. At this time devices such as swirl/vortex concentrators following storage/settling basins are apparently the most flexible and cost-effective method of primary treatment for CSO.

Without clear regulatory guidelines, remote site primary treatment can not be and is not considered as a preliminary strategy selection.



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7.5 SEPARATION STRATEGY OPTIONS

Separation may be feasible in lower-density residential and commercial areas of the city. In these areas there are few if any storm drainage connections to the combined sewer system other than those from curb-side catch basins. Utilities in the streets are not as dense in low and medium density residential areas and therefore are usually not a prohibitive technical or cost consideration.

Separation in combination with on-site source control ordinances and other source control BMPs can be effective in reducing storm water flows, and thus the impact to receiving waters. In the absence of any data on source control ordinance effectiveness for the City of Spokane, separation impacts to receiving waters were evaluated according to the criteria of Chapter 6, including TSS loads. The high concentration of TSS in storm water is a factor against using separation to reduce CSO.

The following are areas that were evaluated for separation. The most feasible areas are shown in Figure 7-21. The details of the evaluation are in Table 7-12. The projected effects on the interceptor system due to separation can seen in Table 7-13.

CSO 2, Hartley and Northwest Boulevard: Adjacent to the Albi stadium area is the Hartley basin, an 84-acre combined basin draining to CSO 2. The small residential area could be separated and the discharge routed to a new outfall on the Spokane River or to swales as described in Section 7.2. This strategy, however, was found to have a relatively high cost per gallon of CSO volume reduction.

CSO 3B, Albi Stadium: This basin meets the one event per year criteria.

CSO 3C, Royal Court: Also adjacent to the Albi stadium area is the Royal Court basin, a 17-acre combined basin draining to CSO 3C. The small residential area could be separated and the discharge routed to a new outfall on the Spokane River or to swales as described in Section 7.2. This strategy, however, was found to have a relatively high cost per gallon of CSO volume reduction.

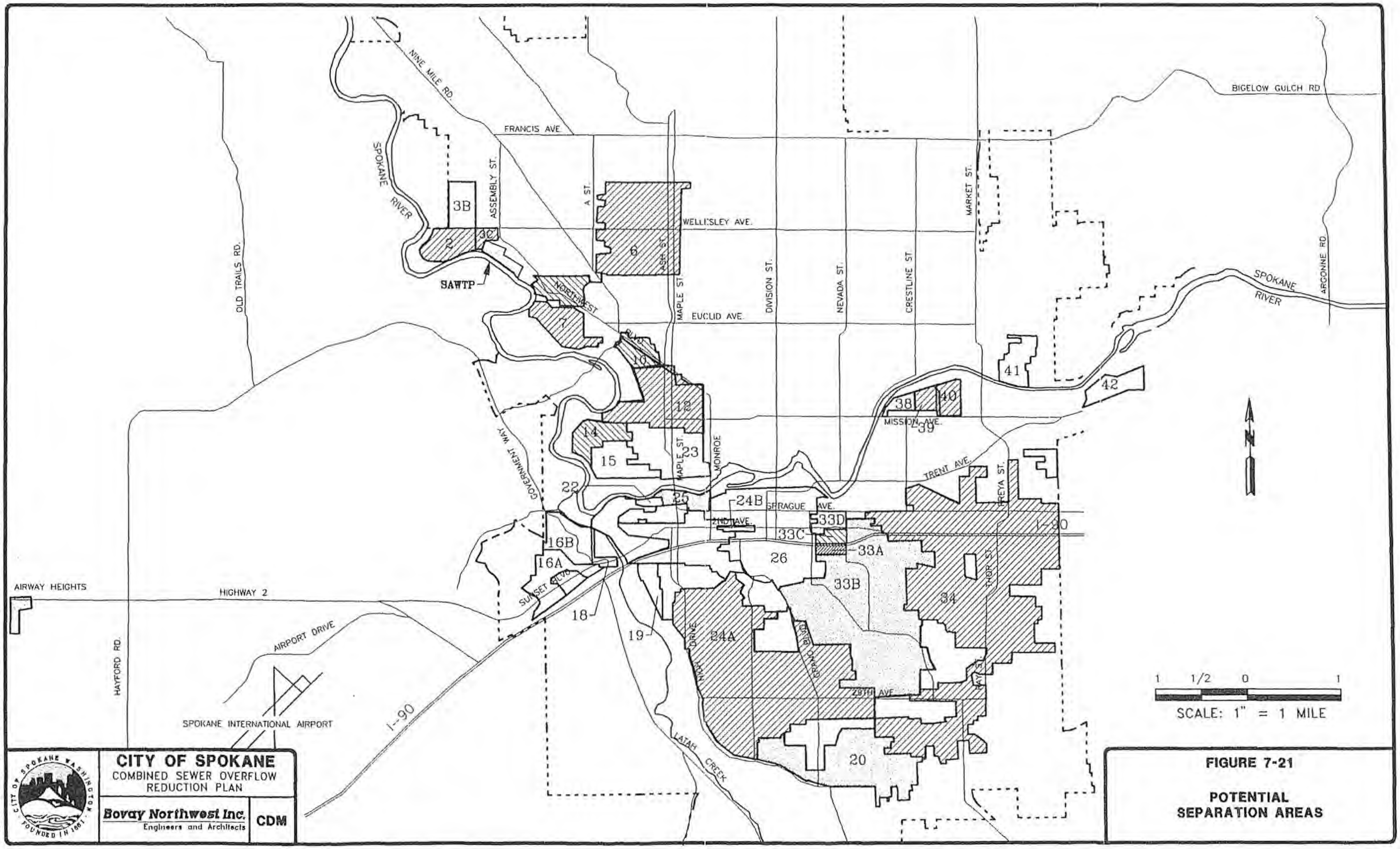

FIGURE 7-21

POTENTIAL SEPARATION AREAS

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TABLE 7-12. SEPARATION OPTIONS

CSO	Present Worth Capital Cost ($1,000)	Annual Maintenance Cost ($1,000)	Present Value ($1,000)	Feasibility
02	526	3	567	All separation options require some treatment.
03C	106	1	115	Use with retention.
06	5,185	21	5,475	
07	1,647	7	1,740	
10	650	3	687	
12	2,991	12	3,159	
14	685	3	723	
15	1,118	5	1,181	
16B	688	3	724	
20	60	0	60	Reconnect to existing outfall.
23	1,457	6	1,538	
24A	14,406	49	15,069	
25	253	1	265	Use with retention.
26	10,343	35	10,819	
33B	12,794	45	13,404	
33C	148	1	155	
33D	475	2	497	
34	13,616	50	14,300	Use with retention.
38	633	3	668	
39	442	2	467	
40	486	2	513	
41	754	3	797	
42	711	3	751	

TABLE 7–13. MODELING CHARACTERISTICS AND RESULTS OF SEPARATION

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1–YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT. FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Surro at S. Riverton	62006	42	0.33	0.64	0.00	0	0.64			0.6	2.0
Surro at S. Riverton	05087		0.11	0.19			0.19	0.6	2.0	0.7	2.5
Waterworks at S. Riverton	05085		0.17	0.32			0.32	0.7	2.5	0.8	1.2
Haven at S. Riverton	05059		0.26	0.45			0.45	0.8	3.7	1.1	12.2
North Valley Interceptor	05058		2.50	3.50			3.50	1.1	12.2	3.9	10.7
Rebecca at Upriver Dr.	56015	41	0.14	0.59	0.00	0	0.59			0.6	1.5
Green at Upriver Drive	56003		0.19	0.63			0.63	0.6	5.7	1.1	30.6
Regal at S. Riverton	57029	40	0.07	0.47	0.00	0	0.47			0.5	0.6
Altamont at S. Riverton	57017	39	0.16	0.42	0.00	0	0.28			0.3	0.3
Magnolia at S. Riverton	57001	38	0.22	0.61	0.00	0	0.69			0.6	0.7
Mission at S. Riverton	05033		0.15	0.51			0.51	5.6	16.2	6.0	16.7
Mallon at S. Riverton	05029		0.42	1.45			1.45	6.0	16.7	7.1	24.6
Front at S. Riverton	05025		0.21	0.38			0.38	7.1	24.6	7.2	25.1
Front at Erie	05023		0.17	0.69			0.69	7.2	25.1	7.6	24.7
Riverside at Napa/Crest.	07099	34	3.50	4.87	0.00	0	4.87			4.8	16.5
Napa at Riverside	59017		0.07	0.34			0.34	4.8	15.4	5.0	15.4
Madelia at Main	59014		0.08	3.33			4.22	5.0	15.4	9.1	15.4
Helena at Front	59011		0.36	1.80			1.90	9.1	15.4	10.8	15.8
Springfield at Superior	52002		0.29	0.98			0.98	7.6	16.2	8.5	16.7
South Valley Interceptor	05015		8.09	11.99			11.99	19.3	57.2	30.4	55.7
5th at Arthur	60396	33A	0.08	0.45	0.00	0	0.45			0.5	2.1
3rd at Perry	60077	33B	2.09	10.64	0.00	0	10.64	11.0	102.1	11.0	16.7
3rd at Arthur	60298	33C	0.06	0.16	0.00	0	0.16			0.2	0.5
1st at Arthur	60299	33D	0.09	0.41	0.00	0	0.41			0.4	0.8
Highdrive near 33rd	61299	20	0.14	0.54	0.00	0	0.55			0.5	6.5
Maple at 10th	55036		0.37	0.66			0.66	0.5	71.3	1.0	77.5
Cedar at Riverside	06014	24	3.30	8.04	0.00	0	8.04	1.0	77.7	9.0	118.7
Lincoln at Spokane Falls	06004	26	8.00	8.33	0.00	0	8.33	9.0	14.1	44.1	154.7
Division at Cataldo	04025		1.17	3.63			3.63			3.6	27.9
Howard at Mallon	04014		0.14	0.43			0.43	2.3	8.7	2.6	13.3
Cedar at Ide	36000	23	0.25	1.20	0.00	0	1.20			1.2	2.3
Sherwood at Summit	37299	14	0.10	0.48	0.00	0	0.48			0.5	0.8
Nettleton at Ohio	37099	15	0.33	0.79	0.00	0	0.79	0.8	3.1	0.8	3.1
Under Freeway Bridge[6]	43099	19	0.05	4.96	0.00	0	4.96			5.0	23.3
Coeur d'Alene at 14th	08017		3.10	11.46			11.46	11.5	44.8	11.5	28.6

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TABLE 7-13. MODELING CHARACTERISTICS AND RESULTS OF SEPARATION (cont.)

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1-YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT. FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Cedar at Main	43029	25	0.12	0.10	0.00	0	0.59			0.6	0.6
Main at Elm St.	43014	22	0.16	0.34	0.00	0	0.34	0.6	0.6	0.6	2.1
"A" Street at Linton	02099	16B	0.26	0.61	0.00	0	0.61			0.6	2.9
"A" Street at Linton	02098	16A	0.24	0.57	0.00	0	0.57			0.6	3.0
1st at A street	02097	18	0.08	1.00	0.00	0	0.25			0.2	0.3
"A" at 1st	08009		0.15	0.40			0.40	11.4	28.4	11.5	29.8
Nora at Pettet	35015	12	0.70	2.29	0.00	0	2.29			2.3	3.7
Cochran at Buckeye	30001	10	0.09	0.47	0.00	0	0.47			0.5	1.0
Cochran Sanitary	03000		6.68	31.33			31.33			93.3	117.6
Columbia Circle	24001	7	0.14	0.34	0.00	0	0.34			0.3	2.1
Kiernan at NW Blvd	29000	6	0.64	3.84	0.00	1	2.94			3.1	3.0
NW Blvd. at Hartley	20099	2	0.05	0.25	0.00	0	0.30			0.3	0.3
NW Blvd. at Assembly	20001	3C	0.07	0.05	0.00	0	0.05	7.2	7.2	7.3	7.1
NW Blvd. at Assembly	20034	3B	0.04	0.93	0.00	1	0.22			0.2	0.4
N.W. Blvd. at Assembly	01006		7.06	7.22			7.22	7.2	25.8	7.3	29.7
N.W. Blvd. at Assembly	01003		0.13	0.11			0.11	7.3	17.8	7.4	22.1
SAWTP[7]			49.06	47.54			96.60	96.6	125.2	96.6	146.0

1. BWWF = Base Wastewater Flow.
2. For unregulated flow, maximum intercepted flow is the 5-yr storm flow.
3. One-year storm flows include average base wastewater flows.
4. mgd = million gallons per day.
5. MG = million gallons.
6. Maximum intercepted flow is the 50-yr storm flow.
7. 2010 dry weather SAWTP flow estimated from the sum of input flows is 49.06 mgd.

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CSO 6, Kiernan and Northwest Boulevard: The combined sewered area immediately south along the north river interceptor from the treatment plant, CSO basin 6, comprises a relatively large area. A major portion of CSO basin 6 is the Shadle Shopping Center, with a large impermeable surface. A partially separate storm sewer for this area draining only municipal street surfaces could be constructed. Separation of the commercial area may be less expensive per acre than separation of the adjacent residential tracts. This is because storm water runoff from the commercial area would likely be handled on-site as noted in Section 7.2. Partial separation in this basin, then, might not include the Shadle Shopping Center. Such a solution would still considerably reduce the storm flows regulated at the CSO 6 site.

CSO 7, Columbia Circle: The combined sewered area adjacent to Downriver Golf Course is CSO Basin 7. Separation of this basin would virtually eliminate storm flow to CSO regulator 7. The cost per gallon of CSO reduction for sewer separation of this basin would be relatively high.

CSO 10, Buckeye: The CSO regulator at Buckeye and Cochran regulates overflow from an area that is primarily medium density residential. The low overflow frequency at CSO regulator 10 makes it a questionable area for cost effective separation. Partial separation should be examined during preparation of the basin plan for this CSO basin. There is some commercial activity using 23 acres within the area served by CSO 10, which may be left as combined sewer.

CSO 12, Nora and Pettet: The CSO regulator at Nora and Pettet regulates overflow from an area that is primarily medium density residential. There is some commercial and industrial activity using 90 acres within the area served by CSO 12, which may be left as combined sewer. The new storm outfall for this area would drain to the Spokane River above the T.J. Meenach Bridge.

CSO 14, Summit and Sherwood: The Summit and Sherwood CSO regulator regulates flow from an older residential neighborhood with virtually no commercial zone. The low frequency of overflow at CSO 14 makes that area questionable for cost effective separation. Partial separation should be examined during preparation of the basin plan for this CSO basin.

CSO 15, Nettleton and Ohio: The Nettleton and Ohio CSO regulator regulates flow from an older residential neighborhood with virtually no commercial zone. Separation of this area would have a moderate initial cost per gallon of CSO volume reduction.

CSO 16A, Geiger: This basin meets the one event per year criteria.

CSO 16B, West Grove: A candidate area for separation is the West Grove sewer draining to A Street at Linton Avenue through CSO regulator 16B. This area is primarily medium density residential, and includes 75 sewered acres. A storm sewer would likely discharge to Latah Creek upstream of the Riverside Avenue Bridge over Latah Creek. There are areas of this basin with shallow basalt and basalt outcrops, which make sewer construction expensive.

CSO 18, Federal Housing Authority: This basin meets the one event per year criteria.

CSO 19, Under Freeway Bridge: This basin meets the one event per year criteria.

CSO 20, West of High Drive, South of 33rd: Flow sources above the regulator at High Drive and 33rd, CSO 20, include several sub-areas totalling 253 acres with separated storm sewer discharging to the combined lines, and 154 acres of combined sewer. The frequency of discharge through this CSO could be reduced to less than one event per year by diverting the already separated storm flow to an existing storm water outfall pipe now carrying flow from a limited area near Comstock Park. There is sufficient capacity in the existing storm drain to carry this discharge. This is a preliminary strategy selection as noted in Section 7.2.

CSO 22, Oak at Main: This basin meets the one event per year criteria.

CSO 23, Cedar & Ide: Separation without BMP strategies may not be a viable alternative for CSO 23, since a large proportion of the area is zoned for commercial activity, and the resulting storm discharge would likely require treatment prior to discharge to the Spokane River. Separation following implementation of the BMP strategies listed for this basin in Section 7.2 was found to have a relatively high cost per gallon of CSO volume reduction.

CSO 24A, Cedar at Riverside, South Hill Basin: This basin is nearly all residential, such that separated storm water might be discharged with minimal treatment under existing regulations. However, much of the area served by CSO 24A is underlain by bedrock at depths of 20 to 36 inches, making separate storm sewer construction quite expensive.

CSO 24B, Cedar and Riverside, Second Avenue Basin: This basin is approximately 20 acres, primarily along Second Avenue east of Cedar Street. The regulator was located during preparation of this Plan; as a result no model analysis has been done for this basin. However, it is unlikely to overflow frequently because the side overflow is eight inches above the influent pipe invert, and within 5 linear feet downstream of the side

overflow point is a 9-inch high dam that must be overtopped prior to overflow reaching the Spokane River. Therefore, there would be little benefit expected from separation.

CSO 25, Cedar at Main: CSO regulator 25 regulates flow from an area that is mostly commercial, and therefore would be difficult for sewer construction as noted in the section on separation in Chapter 5. This basin also has a shallow basalt layer, adding further complexity and cost to sewer construction.

Nevertheless, separation and retention were found to be the most effective and least cost option for CSO basin 25, as described in Section 7.2.

CSO 26, Lincoln at Spokane Falls: CSO regulator 26 regulates flow from an area that is mostly commercial, and therefore would be difficult for sewer construction as noted in the section on separation in Chapter 5. This basin also has a high water table and a shallow basalt layer, adding further complexity and cost to sewer construction.

CSO 33A, Fifth at Arthur: This basin meets the one event per year criteria.

CSO 33B, Third at Perry: This CSO regulates flow from areas that might be conducive to further separation where the deep marble sandy loam makes sewer construction relatively inexpensive. Large areas of the South Hill residential neighborhoods in this combined basin are already separated.

CSO 33C, Third at Arthur: This is a relatively small commercial land use CSO basin. The fact that 33C serves a commercial area makes it unlikely that storm sewers would meet future water quality requirements without treatment.

CSO 33D, First at Arthur: This is a relatively small commercial land use CSO basin. The fact that 33D serves a commercial area makes it unlikely that storm sewers would meet future water quality requirements without treatment.

CSO 34, Between Napa and Crestline on Riverside: This CSO regulates flow from areas that might be conducive to further separation where the deep marble sandy loam makes sewer construction relatively inexpensive. Large areas of the South Hill residential neighborhoods in this combined basin are already separated. The commercial area of Lincoln Heights that is still combined should remain combined to facilitate treatment of runoff from heavily used parking areas.

CSO 38, South Riverton at Magnolia: This is a residential area near the Spokan River. The frequency at CSO regulator 38 is low enough that separation may be less cost effective for that basin than other alternatives.

CSO 39, South Riverton at Altamont: This is a residential area near the Spokane River. Separation would have a moderate cost per gallon of CSO volume reduction for this basin.

CSO 40, South Riverton at Regal: This is a residential area near the Spokane River. Separation would have a moderate cost per gallon of CSO volume reduction for this basin.

CSO 41, Upriver Drive at Rebecca: This is a residential area near the Spokane River. Separation would have a moderate cost per gallon of CSO volume reduction for this basin.

CSO 42, South Riverton at Surro: CSO regulator 42 regulates an area that is partially industrial and will therefore probably be more expensive to separate.

7.6 INCREASED INTERCEPTOR FLOW STRATEGY OPTION

Changing regulator settings to reduce overflow frequencies without source reduction above the regulator allows more flow into the interceptor system during storm events. The approach of this strategy option is to change all weir settings now overflowing more than once per year to one overflow event per year.

This option was examined as a cost comparison and to comply with WAC 173-245-040, which requires that "Treatment/control alternatives, to achieve the greatest reasonable reduction at each CSO site, which shall receive consideration include but are not limited to: ... (iii) increased sewer capacity to the secondary sewage treatment facility which shall provide at least primary treatment and disinfection" (WAC, 1987).

An increase in storm flow and interceptor capacity would force major physical changes at the SAWTP in order to accommodate increased storm flows. As a result, the analysis of increased interceptor capacity includes an assessment of the resulting changes for the SAWTP. Increasing interceptor capacity would entail a major design and construction effort, as the interceptor corridor is shared by arterial streets and other utilities at key locations.

All interceptors were modeled to convey 2010 sanitary flows as well as effluent from all CSO regulators set at one overflow per year. The estimated construction cost to upgrade the interceptor system is $10,300,000. This cost does not include the additional cost of construction in high density areas or resistant basalt rock. Primary treatment plant

capacity would need to be expanded to handle a storm peak hydraulic load of 212 mgd. The capital cost of treatment plant upgrades, in 1992 dollars, is estimated to be $36,000,000. This cost does not include allowances for increased site work and engineering costs incurred for construction on the limited area available while treatment plant operations continue. Table 7-14 is a breakdown of the total cost distributed to each CSO basin according to the resulting reduction in volume. Figure 7-22 shows the major combined sanitary and interceptor lines, including those that would be replaced under the increased interceptor flow strategy option. Table 7-15 is a tabulation of the model characteristics and results from simulating interceptor capacity expansion.

7.7 SUMMARY OF ALTERNATIVES ANALYSIS

The matrix shown in Table 7-16 summarizes the results of the strategy option analyses of this chapter. A similar matrix in Table 7-17 shows the estimated cost per gallon of CSO reduction. The basis of cost comparison between the strategy options is the cost per gallon of reduction in CSO volume. Those alternatives with the lowest cost per gallon that are compatible with reducing overflow frequency to one event per year and meet the other criteria listed in Chapter 6 are preliminary strategy selections. These strategies are discussed in Chapter 8.

TABLE 7-14. INCREASED INTERCEPTOR AND PRIMARY TREATMENT CAPACITY OPTION

CSO No.	Reduction In Annual Volume (MG/Year)[2]	Capital SAWTP Costs ($1,000)	Capital Interceptor Costs ($1,000)	Annual SAWTP[1] Treatment Costs ($1,000)	Total Costs ($1,000)
2	1.70	850	248	0.88	1,109.99
3B	0.00	0	0	0.00	0.00
3C	1.91	957	278	1.00	1,248.86
6	14.00	7,032	2,039	7.28	9,169.96
7	0.70	354	104	0.42	462.92
10	0.25	127	38	0.14	166.75
12	9.40	4,716	1,368	4.98	6,151.28
14	0.83	417	122	0.44	545.02
15	4.37	2,183	634	2.31	2,847.77
16A	0.00	0	0	0.00	0.00
16B	0.48	243	72	0.26	318.29
18	0.00	0	0	0.00	0.00
19	0.00	0	0	0.00	0.00
20	0.00	0	915	0.06	915.41
22	0.00	0	0	0.00	0.00
23	1.63	814	237	0.87	1,062.93
24A	1.63	815	237	1.09	1,067.74
24B[3]					
25	0.32	159	47	0.18	208.95
26	18.70	9,311	2,699	10.17	12,148.98
33A	0.00	0	0	0.00	0.00
33B	1.96	977	284	1.19	1,277.98
33C	0.10	52	16	0.06	68.64
33D	1.97	985	287	1.04	1,285.94
34	11.33	5,644	1,637	6.08	7,363.89
38	0.25	129	39	0.14	169.31
39	1.05	523	153	0.55	683.01
40	1.41	707	206	0.75	922.89
41	0.47	236	69	0.27	308.62
42	0.23	119	36	0.16	157.20
Totals:	74.69	37,350	11,764	40.32	49,662.35

1. SAWTP = Spokane Advanced Wastewater Treatment Plant
2. MG/year = million gallons per year
3. Unknown overflow characteristics; probably low frequency/low volume

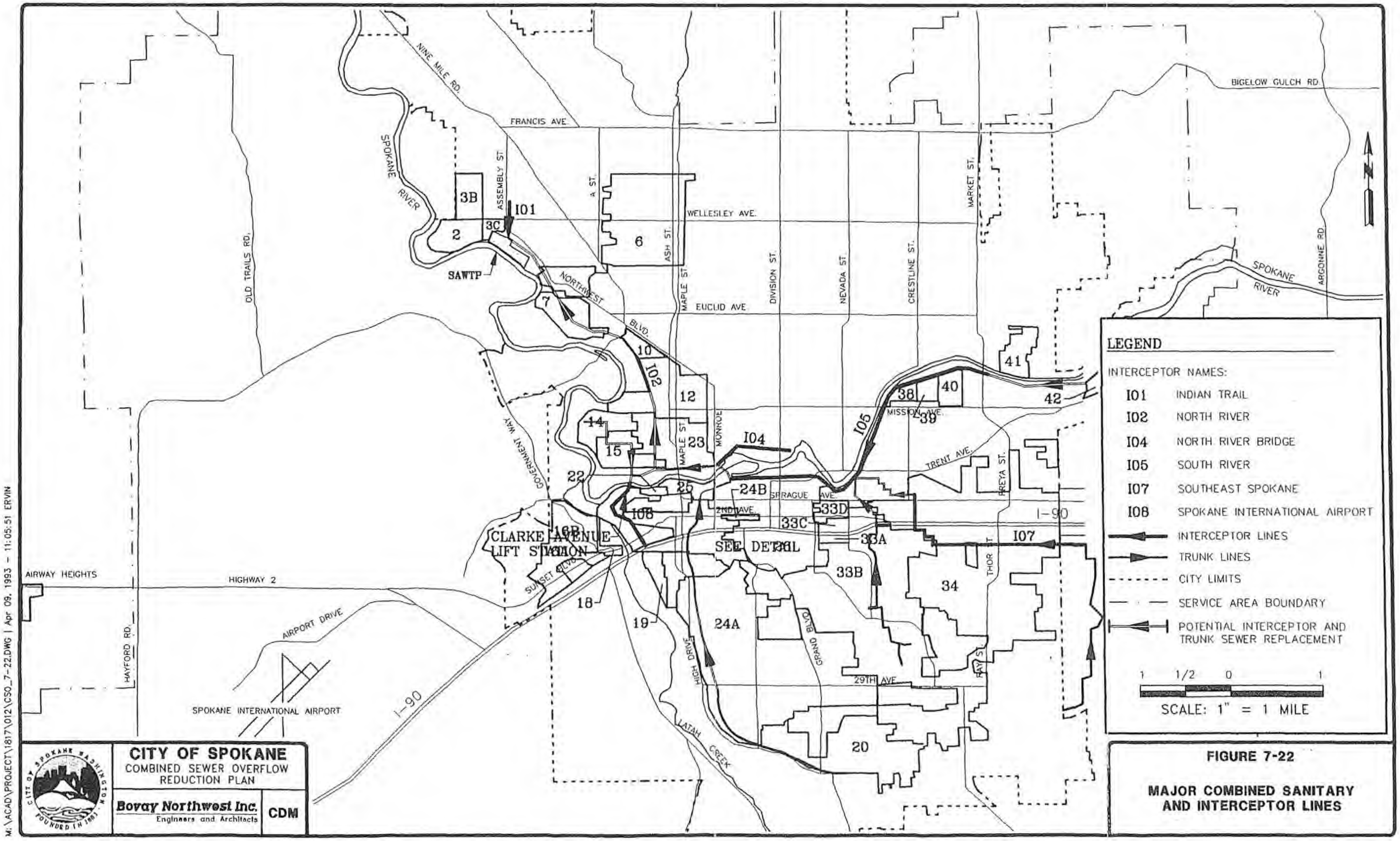

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TABLE 7-15. MODELING CHARACTERISTICS AND RESULTS OF INCREASED INTERCEPTOR AND SAWTP PRIMARY CAPACITY

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1-YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT. FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Surro at S. Riverton	62006	42	0.33	9.70	0.07	1	2.20			2.2	3.4
Surro at S. Riverton	05087		0.11	0.19			0.19	2.2	3.4	3.7	3.7
Waterworks at S. Riverton	05085		0.17	0.32			0.32	3.7	3.7	3.7	3.7
Haven at S. Riverton	05059		0.26	0.45			0.45	3.7	3.7	5.6	12.2
North Valley Interceptor	05058		2.50	3.50			3.50	5.6	12.2	9.1	10.7
Rebecca at Upriver Dr.	56015	41	0.14	11.37	0.05	1	1.60			1.6	1.6
Green at Upriver Drive	56003		0.19	0.63			0.63	1.5	5.7	1.7	30.6
Regal at S. Riverton	57029	40	0.07	5.90	0.03	1	2.01			0.6	0.6
Altamont at S. Riverton	57017	39	0.16	3.53	0.01	1	0.80			0.3	0.3
Magnolia at S. Riverton	57001	38	0.22	5.81	0.02	1	1.33			0.7	0.7
Mission at S. Riverton	05033		0.15	0.51			0.51	8.7	16.2	12.2	16.7
Mallon at S. Riverton	05029		0.42	1.45			1.45	12.2	16.7	12.6	24.6
Front at S. Riverton	05025		0.21	0.38			0.38	12.6	24.6	14.7	25.1
Front at Erie	05023		0.17	0.69			0.69	14.7	25.1	15.5	24.7
Riverside at Napa/Crest.[6]	07099	34	3.50	81.65	0.46	1	32.14			47.6	55.7
Napa at Riverside	59017		0.07	0.34			0.34			0.3	15.4
Madelia at Main	59014		0.08	3.33			4.22	0.3	15.4	3.0	15.4
Helena at Front	59011		0.36	11.73			14.75	3.0	15.4	7.6	15.8
Springfield at Superior	52002		0.29	0.98			0.98			0.6	0.7
South Valley Interceptor	05015		8.09	11.99			12.00	41.5	57.2	60.2	60.7
5th at Arthur	60396	33A	0.08	5.77	0.00	0	2.00			0.8	2.1
3rd at Perry	60077	33B	2.09	99.57	0.34	1	27.97	99.6	102.1	18.1	16.7
3rd at Arthur	60298	33C	0.06	2.78	0.02	1	0.82			0.3	0.5
1st at Arthur	60299	33D	0.09	14.08	0.05	1	2.73			0.8	0.8
Highdrive near 33rd	61299	20	0.14	0.54	0.00	0	0.64			6.8	6.5
Maple at 10th	55036		0.37	0.66			0.66	49.8	71.3	66.0	77.5
Cedar at Riverside	06014	24	3.30	54.17	1.00	1	17.32	65.4	77.7	17.4	17.4
Lincoln at Spokane Falls	06004	26	8.00	85.30	2.04	1	62.77	89.7	154.7	62.8	62.8
Division at Cataldo	04025		1.17	3.63			3.63			4.9	27.9
Howard at Mallon	04014		0.14	0.43			0.43	4.9	8.7	5.0	13.3
Cedar at Ide	36000	23	0.25	12.97	0.05	1	3.50			3.5	4.2
Sherwood at Summit	37299	14	0.10	5.65	0.02	1	2.01			2.0	2.0
Nettleton at Ohio	37099	15	0.33	8.93	0.09	1	4.83			4.8	4.8
Under Freeway Bridge[7]	43099	19	0.05	4.96	0.00	0	34.11			4.8	23.3
Coeur d'Alene at 14th	08017		3.10	11.46			11.50			18.9	28.6

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TABLE 7-15. MODELING CHARACTERISTICS AND RESULTS OF INCREASED INTERCEPTOR AND SAWTP PRIMARY CAPACITY (cont.)

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1-YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT. FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Cedar at Main	43029	25	0.12	0.06	0.00	0	0.09			0.1	0.6
Main at Oak St.	43014	22	0.16	3.75	0.00	0	2.20	0.1	0.6	1.2	2.1
"A" Street at Linton	02099	16B	0.26	9.59	0.02	1	2.49			2.6	2.9
"A" Street at Linton	02098	16A	0.24	3.95	0.01	0	2.90			2.1	3.0
1st at A street	02097	18	0.08	1.00	0.00	1	0.25			0.3	0.3
"A" at 1st	08009		0.15	0.40			0.40	18.8	28.4	18.9	29.8
Nora at Pettet	35015	12	0.70	50.14	0.61	1	12.37			12.4	5.8
Cochran at Buckeye	30001	10	0.09	7.17	0.02	1	1.70			1.7	2.0
Cochran Sanitary	03000		6.68	31.33			31.33			172.4	183.3
Columbia Circle	24001	7	0.14	10.29	0.10	1	4.21			4.2	4.2
Kiernan at NW Blvd	29000	6	0.64	48.95	0.44	1	12.91			8.3	8.3
NW Blvd. at Hartley	20099	2	0.05	4.45	0.01	1	1.10			1.1	2.8
NW Blvd. at Assembly	20001	3C	0.07	2.11	0.02	1	1.12	1.0	7.2	3.0	7.1
NW Blvd. at Assembly	20034	3B	0.04	0.93	0.00	1	0.22			0.2	0.4
N.W. Blvd. at Assembly	01006		7.07	7.22			3.02	15.5	25.8	15.8	29.7
N.W. Blvd. at Assembly	01003		0.13	0.13			0.11	16.2	17.8	16.0	22.1
SAWTP[8]			49.07	149.93	5.47		199.00	183.0	183.3	199.0	200.0

1. BWWF = Base Wastewater Flow.
2. For unregulated flow, maximum intercepted flow is the 5-yr storm flow.
3. One-year storm flows include average base wastewater flows.
4. mgd = million gallons per day.
5. MG = million gallons.
6. Flow calculated assuming the existing overflow pipe converted back to combined flow, overflowing at Front and Erie.
7. Maximum intercepted flow is the 50-yr storm flow.
8. 2010 dry weather SAWTP flow estimated from the sum of input flows is 49.07 mgd.

TABLE 7-16. PRELIMINARY PROJECT SELECTIONS FOR EACH CSO

CSO	On-Site Retention	On-Site Detention	Interceptor Optimization	CSO 6 Storage	CSO 12 Storage	East Trent Central Storage	Riverfront w/o 24A Storage	Maple & Pacific Storage	Separation
2			X						
3C	X								X
6	X			X					
7	X		X						
10			X						
12	X				X				
14					X				
15	X				X				
16B			X						
20									X
23		X	X						
24A								X	
25	X								X
26							X		
33B	X					X			
33C						X			
33D						X			
34						X			
38						X			
39	X					X			
40	X					X			
41	X					X			
42	X					X			

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TABLE 7-17. COST PER GALLON OF REDUCTION FOR EACH CSO ALTERNATIVE[1]

CSO	On-Site Retention ($/gal.)	On-Site Detention ($/gal.)	Interceptor Optimization ($/gal.)	CSO 6 Storage ($/gal.)	CSO 12 Storage ($/gal.)	East Trent Central Storage ($/gal.)	Riverfront w/o 24 Storage ($/gal.)	Maple & Pacific Storage ($/gal.)	Separation ($/gal.)
2	0.41		0.25						0.33
3C	0.16		0.31						0.06
6	0.06		0.30	0.14					0.39
7	0.37		1.12						2.15
10			1.46						2.54
12	0.02		0.96		0.12				0.33
14			0.63		0.29				0.84
15	0.11		0.25		0.13				0.26
16B		3.81	0.26						1.45
20	966.00								0.54
23		1.79	0.62						0.91
24A	1.26		0.99					0.46	7.11
25	2.00		6.19						0.76
26		0.90	0.91				0.28		0.55
33B	0.36					0.56			5.83
33C		7.20	1.61			0.57			1.29
33D		0.86	0.45			0.49			0.25
34	1.45		0.40			0.49			1.21
38	0.71		1.68			0.51			2.39
39	0.09		0.58			0.48			0.44
40	0.07		0.63			0.48			0.35
41	0.25		1.41			0.52			1.53
42	0.39		1.67			0.61			2.42

1. The costs per gallon in this table correspond with Table M-1, and are based on engineering and construction costs, plus annualized maintenance and operation costs and treatment costs. Treatment plant costs are allocated at $6 per gallon.

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BOVAY
NORTHWEST

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CHAPTER 8. CONTROL TREATMENT PROJECTS

This Chapter presents the priority ranked project schedule to address reduction of combined sewer overflow in Spokane. Five general control/treatment project options are presented first. A control/treatment project approach was selected from these options. Each basin project in the selected approach schedule is described. These projects, shown in Table 7-16, have been screened using the criteria discussed in Chapter 6. The project schedule provides for "the greatest reasonable reduction of combined sewer overflows at the earliest possible date" taking into account the factors outlined in Chapter 6.

8.1 PRIORITY RANKING

WAC 173-245-040, CSO Reduction Plan, requires that each municipality propose a ranking of its selected treatment/control projects using the following criteria.

1. Highest priority shall be given to reduction of CSOs which discharge near water supply intakes, public primary contact recreation areas, and potentially harvestable shellfish areas.

2. Documented, probable, and potential environmental impacts of the existing CSO discharges.

3. A cost-effectiveness analysis of the proposed projects. This can include a determination of the monetary cost per annual mass pollutant reduction, per annual volume reduction, and/or per annual frequency reduction achieved by each project.

Spokane does not have any surface water supply intakes from the Spokane River, public primary contact areas, or harvestable shellfish areas near any of its outfalls. Therefore this criterion does not affect the ranking of projects. Downstream of all the outfalls there are a number of public beaches at Long Lake which are affected by all CSOs.

Analysis of overflow discharge from representative CSO regulator chambers shows that the concentration of potential pollutants is basically the same for all CSOs, so that environmental impacts are directly related to annual volume. As a result, a given project's volume and frequency reduction at the affected CSO were used as the primary ranking of the project, as developed in Chapter 6. Table 8-1 lists the CSOs according to existing volume and frequency of discharge.

TABLE 8-1. CSO REGULATORS RANKED BY VOLUME

CSO No.	CSO Location	Annual Overflow Volume[1, 2] (MG)[4]	Frequency of Overflows[3] (annual)
26	Lincoln at Spokane Falls	19.73	15
6	Kiernan at NW Blvd.	14.12	34
34	Riverside at Napa/Crestline	11.78	13
12	Nora at Pettet	9.65	35
15	Nettleton at Ohio	4.47	4
33B	3rd at Perry	2.30	5
24	Cedar at Riverside	2.12	3
33D	1st at Arthur	2.03	42
3C	NW Blvd. at Assembly (from Royal)	1.94	51
2	NW Blvd. at Hartley	1.72	40
23	Cedar at Ide	1.69	18
40	Regal at S. Riverton	1.45	32
39	Altamont at S. Riverton	1.06	34
14	Sherwood at Summit	0.86	17
7	Columbia Circle	0.81	13
41	Rebecca at Upriver Dr.	0.52	11
16B	"A" Street at Linton	0.50	12
25	Cedar at Main	0.35	19
42	Surro at S. Riverton	0.31	7
38	Magnolia at S. Riverton	0.28	10
10	Cochran at Buckeye	0.27	7
33C	3rd at Arthur	0.12	11
20	High Drive near 33rd	0.55	2
16A	"A" Street at Linton	0.01	0
3B	NW Blvd. at Assembly (from Albi)	0.00	1
18	1st at A Street	0.00	1
19	Under Freeway Bridge	0.00	0
22	Main at Oak St.	0.00	0
33A	5th at Arthur	0.00	0
TOTAL:		78.64	

1. STORM simulation includes effects of snowmelt.
2. Values rounded to nearest 10,000 gal.
3. A "0" indicates less than one event in 2 years.
4. MG = million gallons

The second screening tool for ranking projects was cost effectiveness. All projects for reducing overflow applicable to a given CSO were ranked according to cost per gallon of CSO volume reduction. Those projects addressing overflow at a particular CSO that were the lowest cost for that CSO were then re-evaluated in combination with other volume reduction projects in order to achieve the one overflow per year per outfall goal.

Finally, projects were screened for other criteria in Chapter 6, including impact to the interceptor and treatment plant capacities, operations complexity, and future regulations.

8.2 CSO REDUCTION PROJECT OPTIONS

Five project options for addressing CSO reduction were evaluated using the criteria developed in Chapter 6. These project options are shown in Table 8-2. The most cost effective approach that meets the criteria of Chapter 6 is shown as item 2, storage with existing capacity optimization. Section 8.3 addresses the specific components of this project option.

8.3 CSO REDUCTION PROJECT SCHEDULE

The four phase project schedule and costs for reducing the City of Spokane's combined sewer overflows are shown in Table 8-3. The locations and affected basins of the first phase projects are shown in Figure 8-1. The first phase of the program will be to write and then implement basin plans for the 15 largest CSO basins. The basin plans will consider the ordinances and BMP projects recommended in this CSO Reduction Plan as well as additional projects that may be applicable.

The second phase of CSO reduction in Spokane will be to evaluate the effectiveness of the first 15 basin plan BMP projects and update this plan with the results of the new information, including modeling the combined sewer system with any revised projects. Following the CSO reduction plan update, the remaining projects outlined in this report but subject to revision during plan updates will be implemented during the final two phases of CSO reduction to achieve the one event per year (on average) goal for each CSO outfall.

The third phase covers the remainder of the period to 2010, including writing basin plans for the CSOs currently discharging more than once per year that were not covered in the first phase. Phase 3 basin plans are separate from those in Phase 1 to allow for evaluation and better design of Phase 3 projects, if necessary, following analysis of the first set of projects in Phase 2. Phase 3 also includes improvements to the existing interceptor system and the wastewater treatment plant.

TABLE 8-2. CSO REDUCTION PROJECT OPTIONS[1]

	1. No Additional Reduction Beyond Best Management Practice	2. Storage With Exist. Capacity Optimization	3. Remote-Site Treatment	4. Separate Remaining Basins	5. Expand Interceptor and SAWTP[2] Capacity
Cost[3]:	$0	$33,189,000 ($.64 per gallon)	$34,197,000 ($.66 per gallon)	$74,359,000 ($1.24 per gallon)	$50,000,000 ($.83 per gallon)
Advantages:	No additional cost.	Lowest cost to meet Ecology's one event per year criteria.	Relatively low cost.	Elimination of CSO to SAWTP.	Elimination of untreated CSO discharge.
	Low maintenance.	Does not impact existing peak flow capacity at SAWTP with proper control for 5-year storms.	Elimination of most CSO to SAWTP. Reduces overflow to 8.4 MG per year.	Total separation of all CSO basins.	Lower cost than separation.
	No added impact on treatment plant.	Reduces overflow to 8.4 MG per year, on average.	Sized to handle 2010 increases projected with draft facility plan.	Will not require any interceptor capacity increases.	Will not require remote facilities.
	No additional discharge points.	Sized to handle 2010 increases projected with draft facility plan.	Will not require major interceptor capacity increases.		No additional untreated storm water discharge.
Disadvantages:	Will not meet the State's one event per year criteria.	Will require capacity increase for interceptor (not in above cost) immediately above SAWTP to avoid surcharging the interceptor.	State standards for treatment of CSO are unclear and will probably become more stringent.	State standards for treatment of storm water will probably be implemented in the future.	High cost solution.
	Will leave almost 60 MG of CSO per year.	Will decrease the average daily capacity of the plant for new, rate-paid sanitary wastewater sources.	New outfalls would need to be in city NPDES permit.	High cost solution.	The necessary amount of land is probably not available at the SAWTP site.
	Still allows a peak flow of 140 mgd to SAWTP which may necessitate replacing joints in interceptor immediately above SAWTP.	Still allows a peak flow of 130 mgd to SAWTP during storm events.	New outfalls would be subject to mixing zone requirements for treatment plants.	Total suspended solids discharge to river may actually increase.	May make capacity modifications to handle additional sanitary flow more difficult.
		Requires treatment of nearly all storm water at SAWTP.	Higher cost than storage with capacity optimization.		
		New NPDES[4] outfall from East Trent storage site.	Still requires treatment of highly concentrated waste from remote-site treatment facilities.		

1. All options include utilizing Best Management Practice (BMP) to the fullest practical extent, including retention swales, sewer use ordinances and maintenance. The cost of this step is estimated to be $6,560,000 to reduce CSO by 18 MG per year ($.36 per gallon).
2. SAWTP= Spokane Advanced Wastewater Treatment Plant.
3. All costs are in 1992 dollars.
4. NPDES= National Pollutant Discharge Elimination System.

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TABLE 8-3. CSO REDUCTION SCHEDULE

Year	CSO Basin Regulator	Projects	Capital Cost ($1,000)	Annual Maint. & Operation ($1,000)
Phase 1				
1994	26	Basin Plan	100	0
1995	26 6 34 12 15	I/I* Reduction Basin Plan Basin Plan Basin Plan Basin Plan/Monitor	100 50 50 50 50	0 0 0 0 0
1996	26 6 34 12 33B 24 33D 3C&2	Weir Modification, I/I Retention,I/I Reduction, Weir Modif. I/I Reduction, Weir Change Retention, I/I Reduction, Weir Basin Plan Basin Plan Basin Plan Basin Plan	160 303 110 152 25 25 25 25	0.1 2.1 0.1 0.5 0 0 0 0
1997	15 33B 24 33D 3C&2 23 38,39,40 14 7 41 16B	Retention, I/I Reduction, Weir Modif. Retention, I/I Reduction, Weir Modif. I/I Reduction, Weir Modification I/I Reduction, Weir Modification I/I Reduction, Weir Modif., Monitor Basin Plan Basin Plan Basin Plan Basin Plan Basin Plan Basin Plan	371 272 110 85 155 25 25 25 25 25 25	2.8 1.6 0.1 0.2 0.3 0 0 0 0 0 0
1998	23 38 39 40 14 7 41 16B	Detention Storage, I/I, Weir Modif. I/I Reduction, Weir Modification Retention, I/I Reduction, Weir Modif. Retention, I/I Reduction, Weir Modif. I/I Reduction, Weir Modification Retention, I/I Reduction, Weir Modif. Retention, I/I Reduction, Weir Modif. I/I Reduction, Weir Modification	1,470 70 121 157 70 651 124 70	1.1 0.1 0.9 1.0 0.1 1.9 0.6 0.1
		Phase 1 - Subtotal	5,101	13.6
Phase 2				
1999 to 2000		CSO Reduction Plan Update, includes Review and Analysis, Revision of Projects	250	0
		Phase 2 - Subtotal	250	0
Phase 3				
2001	25 42 10 33C 20	Basin Plan Basin Plan Basin Plan Basin Plan Basin Plan	25 25 25 25 25	0 0 0 0 0

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TABLE 8-3. CSO REDUCTION SCHEDULE (cont.)

Year	CSO Basin Regulator	Projects	Capital Cost ($1,000)	Annual Maint. & Operation ($1,000)
2002	3C 25 42 38 10 33C 20	Retention, Separation Retention, Separation I/I, Weir Change I/I, Weir Change I/I, Weir Change I/I, Weir Change Separation, I/I	273 377 118 70 70 70 80	2.7 2.6 0.5 0.1 0.1 0.1 0.1
2003 to 2005		Interceptor Upgrades	5,476	0
2006 to 2008		SAWTP[2] Upgrades	2,500	4
2009	2 23 7 16B 10	Optimization Optimization Optimization Optimization Optimization	1 1 1 1 1	0 0 0 0 0
		Phase 3 - Subtotal	9,164	9.2
Phase 4				
2010 to 2012		CSO Reduction Plan Update, including Review and Analysis, Revision of Projects	250	0
After 2012	6	1.7 MG[3] Off-Line Storage Treatment Cost	1,499 425	6.8
	12,14,15 West Central	1.5 MG Off-Line Storage Treatment Cost	1,217 375	6.0
	24 Maple & Pacific	0.9 MG Off-Line Storage Treatment Cost	573 225	3.4
	26 Riverfront Park	5 MG Off-Line Storage Treatment Cost	3,423 1,250	20
	33A, 33B, 33C, 33D, 34,38,39, 40,41,42 East Trent Site	8.5 MG Off-Line Storage Treatment Cost	6,836 2,125	34
2017		44 mgd[4] Primary Clarifier Capacity	7,000	32
		Phase 4 Subtotals	25,198	102.2
CSO REDUCTION TOTALS			39,713	125.0

1. I/I= infiltration/inflow
2. SAWTP- Spokane Advanced Wastewater Treatment Plant
3. MG= million gallons
4. mgd= million gallons per day

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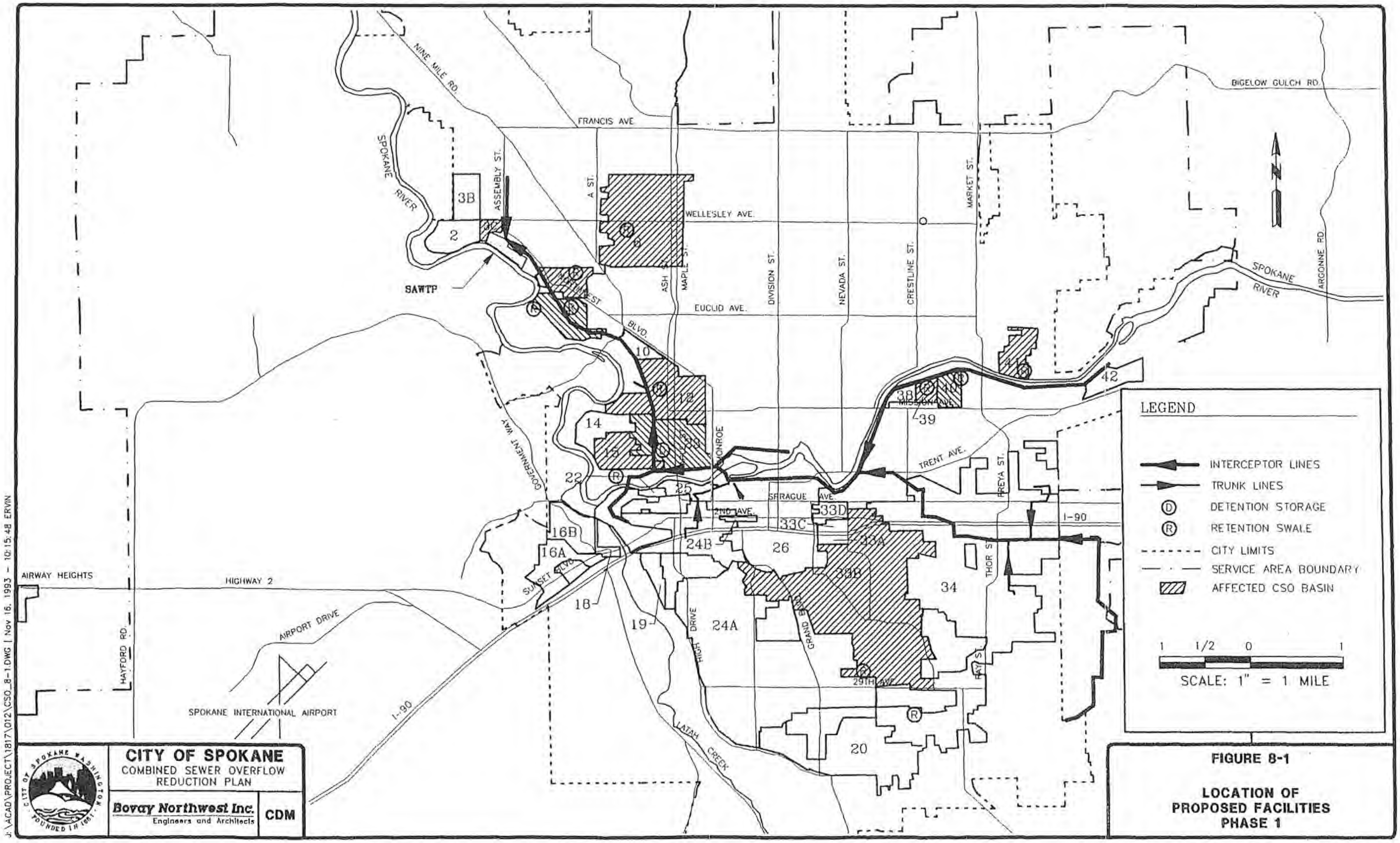

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The fourth and final phase of implementation will occur after 2012, and be preceded by a final update of this plan based on data from projects implemented during the first three phases. The fourth phase will include capital intensive projects to construct remote storage. These projects are presented for the purpose of project identification in this plan. The locations and affected basins of projects in the third and fourth phases are shown in Figure 8-2. Following completion of the fourth phase, the CSO reduction program is anticipated to affect interceptor and SAWTP capacity as shown in Table 8-4.

8.3.1 Phase 1

The initial basin plans are for those basins found to discharge the greatest amount of CSO as shown in Table 8-1. The BMP and weir modification projects listed in Table 8-3 are those found to be most cost effective in the analysis presented in Chapter 7. The additional analysis in the individual basin plans may indicate better alternatives which will be implemented instead of those listed in Table 8-3. These projects will be re-evaluated for effectiveness through analysis of long-term flow monitor data collected at new regulating structures downstream of the projects. The existing long-term flow monitoring and rainfall data gathering efforts will be continued. As required by Ecology, a SEPA environmental checklist will be submitted that will cover the pilot projects.

Basin plans will be engineering reports from which plans and specifications can be developed for specific CSO reduction projects. The plans will be prepared according to the following outline, adapted from the *Stormwater Management Manual for the Puget Sound Basin* (Ecology, 1992):

I. Project overview
II. A plot plan, including:
   - locations of structures, other impervious surfaces
   - locations of storm water runoff control facilities
   - existing basin features
   - water quality sensitive areas
   - road rights-of-way and easements
III. Preliminary conditions summary, including effects of zoning and ordinances, both existing and those proposed in this CSO reduction plan
IV. Off-site analysis of water quality and quantity
V. Analysis and preliminary design of proposed storm water runoff control facilities, including treatment and source control BMPs
VI. Special reports and studies relating to the subject CSO basin
VII. Applicable permits

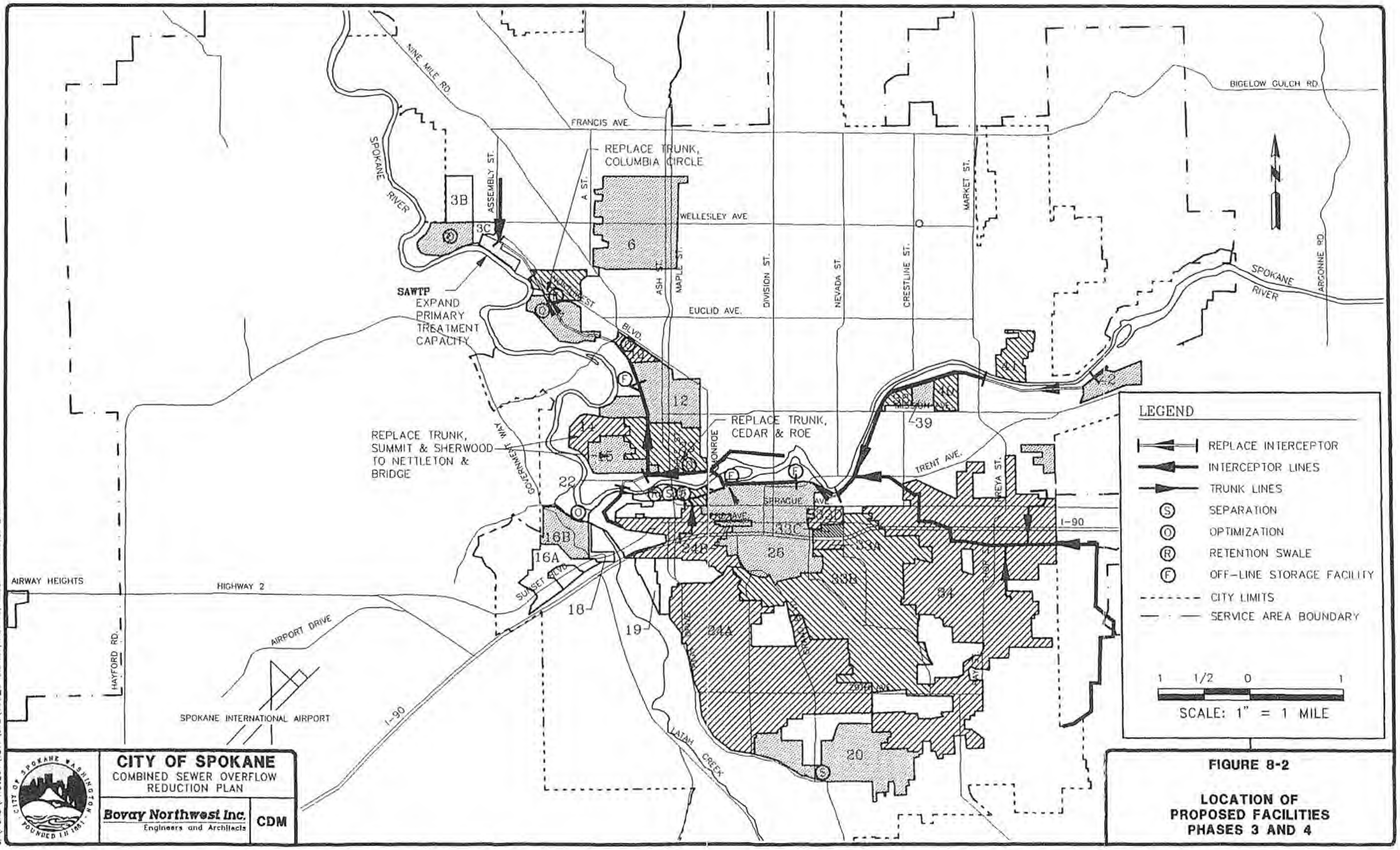

FIGURE 8-2

LOCATION OF PROPOSED FACILITIES PHASES 3 AND 4

TABLE 8-4. MODELING CHARACTERISTICS AND RESULTS OF SELECTED PROJECT OPTION

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1-YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT. FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Surro at S. Riverton	62006	42	0.33	9.70	0.07	1	2.20			2.2	3.4
Surro at S. Riverton	05087		0.11	0.19			0.19	2.2	3.4	3.7	3.7
Waterworks at S. Riverton	05085		0.17	0.32			0.32	3.7	3.7	3.7	3.7
Haven at S. Riverton	05059		0.26	0.45			0.45	3.7	3.7	5.6	12.2
North Valley Interceptor	05058		2.50	3.50			3.50	5.6	12.2	9.1	10.7
Rebecca at Upriver Dr.	56015	41	0.14	11.37	0.05	1	1.60			1.6	1.6
Green at Upriver Drive	56003		0.19	0.63			0.63	1.5	5.7	1.7	30.6
Regal at S. Riverton	57029	40	0.07	5.90	0.03	1	2.01			0.6	0.6
Altamont at S. Riverton	57017	39	0.16	3.53	0.01	1	0.80			0.3	0.3
Magnolia at S. Riverton	57001	38	0.22	5.81	0.02	1	1.33			0.7	0.7
Mission at S. Riverton	05033		0.15	0.51			0.51	8.7	16.2	12.2	16.7
Mallon at S. Riverton	05029		0.42	1.45			1.45	12.2	16.7	12.6	24.6
Front at S. Riverton	05025		0.21	0.38			0.38	12.6	24.6	14.7	25.1
Front at Erie	05023		0.17	0.69			0.69	14.7	25.1	15.5	24.7
Riverside at Napa/Crest.[6]	07099	34	3.50	81.65	0.46	1	32.14			47.6	55.7
Napa at Riverside	59017		0.07	0.34			0.34			0.3	15.4
Madelia at Main	59014		0.08	3.33			4.22	0.3	15.4	3.0	15.4
Helena at Front	59011		0.36	11.73			14.75	3.0	15.4	7.6	15.8
Springfield at Superior	52002		0.29	0.98			0.98			0.6	0.7
South Valley Interceptor	05015		8.09	11.99			12.00	41.5	57.2	60.2	60.7
5th at Arthur	60396	33A	0.08	5.77	0.00	0	2.00			0.8	2.1
3rd at Perry	60077	33B	2.09	99.57	0.34	1	27.97	99.6	102.1	18.1	16.7
3rd at Arthur	60298	33C	0.06	2.78	0.02	1	0.82			0.3	0.5
1st at Arthur	60299	33D	0.09	14.08	0.05	1	2.73			0.8	0.8
East Trent Storage[7]	05009				2.93	1	34.4	72.4	78.2	48.4	51.6
Highdrive near 33rd	61299	20	0.14	0.54	0.00	0	0.64			6.8	6.5
Maple at 10th	55036		0.37	0.66			0.66	49.8	71.3	66.0	77.5
Cedar at Riverside	06014	24	3.30	54.17	1.00	1	12.20	65.4	77.7	13.0	14.1
Lincoln at Spokane Falls	06004	26	8.00	85.30	2.04	1	36.80	89.7	154.7	36.8	36.6
Division at Cataldo	04025		1.17	3.63			3.63			4.9	27.9
Howard at Mallon	04014		0.14	0.43			0.43	4.9	8.7	5.0	13.3
Cedar at Ide	36000	23	0.25	12.97	0.05	1	3.50			3.5	4.2
Sherwood at Summit	37299	14	0.10	5.65	0.02	1	2.01			2.0	2.0
Nettleton at Ohio	37099	15	0.33	8.93	0.09	1	4.83			4.8	4.8
Under Freeway Bridge[8]	43099	19	0.05	4.96	0.00	0	34.11			4.8	23.3

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TABLE 8-4. MODELING CHARACTERISTICS AND RESULTS OF SELECTED PROJECT OPTION (cont.)

LOCATION		TRUNK INTERSECTIONS					INTERCEPTOR				
		CSO	BWWF[1]	1-YR STORM	ANN. OVERFLOW		MAX.[2]	UPSTREAM		DOWNSTREAM	
STREET IDENTIFICATION	EXTRAN IDENT.	No.	AVG. (mgd)[4]	FLOW[3] (mgd)	VOL. (MG)[5]	FREQ.	INTERCEPT. FLOW (mgd)	FLOW (mgd)	CAPACITY (mgd)	FLOW (mgd)	CAPACITY (mgd)
Coeur d'Alene at 14th	08017		3.10	11.46			11.50			18.9	28.6
Cedar at Main	43029	25	0.12	0.06	0.00	0	0.09			0.1	0.6
Main at Oak St.	43014	22	0.16	3.75	0.00	0	2.20	0.1	0.6	1.2	2.1
"A" Street at Linton	02099	16B	0.26	9.59	0.02	1	2.49			2.6	2.9
"A" Street at Linton	02098	16A	0.24	3.95	0.01	0	2.90			2.1	3.0
1st at A street	02097	18	0.08	1.00	0.00	1	0.25			0.3	0.3
"A" at 1st	08009		0.15	0.40			0.40	18.8	28.4	18.9	29.8
Nora at Pettet	35015	12	0.70	50.14	0.61	1	5.80			5.8	5.8
Cochran at Buckeye	30001	10	0.09	7.17	0.02	1	1.70			1.7	2.0
Cochran Sanitary	03000		6.68	31.33			31.33			133.5	117.6
Columbia Circle	24001	7	0.14	10.29	0.10	1	4.21			4.2	4.2
Kiernan at NW Blvd	29000	6	0.64	48.95	0.44	1	2.94			2.9	2.9
NW Blvd. at Hartley	20099	2	0.05	4.45	0.01	1	1.10			1.1	2.8
NW Blvd. at Assembly	20001	3C	0.07	2.11	0.02	1	1.12	1.0	7.2	3.0	7.1
NW Blvd. at Assembly	20034	3B	0.04	0.93	0.00	1	0.22			0.2	0.4
N.W. Blvd. at Assembly	01006		7.07	7.22			3.02	15.5	25.8	15.8	29.7
N.W. Blvd. at Assembly	01003		0.13	0.13			0.11	16.2	17.8	16.0	22.1
SAWTP[9]			49.07	87.53	8.40		136.60	136.6	125.2	136.6	146.0

1. BWWF = Base Wastewater Flow.
2. For unregulated flow, maximum intercepted flow is the 5-yr storm flow.
3. One-year storm flows include average base wastewater flows.
4. mgd = million gallons per day.
5. MG = million gallons.
6. Flow calculated assuming the existing overflow pipe converted back to combined flow, overflowing at Front and Erie.
7. The proposed East Trent storage site is not an existing overflow; the maximum intercepted flow is the maximum combined flow that bypasses the storage facility.
8. Maximum intercepted flow is the 50-yr storm flow.
9. 2010 dry weather SAWTP flow estimated from the sum of input flows is 48.01 mgd.

VIII. Erosion and sediment control plan, per I-3.4 of the *Stormwater Management Manual for the Puget Sound Basin*

IX. Quantities worksheet, retention/detention facility summary sheet and sketch(s)

X. Maintenance and operations guidelines.

Following preparation of the applicable basin plans, the proposed first phase projects are listed below.

- Enhancements to the existing City regulations, discussed in Chapters 5 and 7, are recommended for development and study to make CSO control more effective. Specifically, these actions and revised regulations are:

  - Provide a financial incentive for businesses that store peak runoff on-site. Approved storage methods will include on-site retention swales in parking lots and on-site detention tanks. The amount of the rate reduction may be related to the amount of peak runoff reduction.

  - Conduct an investigation in cooperation with building owners in the central business district to determine the extent of inflow from basement sumps. A consensus solution will be developed and agreed upon by downtown building owners to address inflow from basement sumps to the combined sewer system. Part of such a solution may be a revised wastewater rate structure.

- In conjunction with the preparation of CSO basin plans, investigation of potential I/I source reduction will be conducted. From the investigation will follow the design of recommended improvements to reduce I/I in the specific basins. These recommended improvements will then be implemented.

- Replacement of all CSO regulating structures regulating overflows. The new regulating structures will enable accurate measurement and control of discharges to the interceptor system as basin plans are completed. A long-term monitor will be installed at CSO regulator 3C to ascertain the effectiveness of BMP implementation in basins 2 and 3C.

- On-site retention swales in CSO basins 6, 12, 15, 33B, 39, 40, 7, and 41. These retention swales are detailed in Chapter 7. A new long-term flow monitor will be installed at regulator structure 15 to evaluate the effectiveness of the flow reduction project at that site.

- Construct the on-site detention facility for CSO basin 23 identified in the CSO reduction schedule.

Better on-site control implemented in Phase 1 will reduce flows received by combined sewers by intercepting runoff from impervious areas and inflow prior to reaching the combined sewer system.

8.3.2 Phase 2

In 1999 to 2000, the remaining projects in the CSO reduction schedule will be revised using information from the evaluation of the effectiveness of the Phase 1 projects. Planned studies include the following.

- Analyze flow records from flow monitoring with monitors installed during the first phase.

- Based on analysis of first phase project results, calculations for the remaining CSO basin plans and control projects will be revised.

- An updated SEPA environmental checklist will be submitted for the remaining CSO control projects.

Completion of the second phase studies will enable a thoroughly planned CSO reduction effort to achieve the one event per year goal.

8.3.3 Phase 3

Projects and costs estimated for this phase are contingent upon the reduction achieved following completion of the first and second phases. Continued monitoring of CSO regulating structures and the interceptor system will be critical to evaluating the success of the projects as they are implemented. Major projects associated with the third phase include:

- Preparation of the remaining five basin plans for CSO regulating structures discharging CSO more than once per year

- Construct the remaining on-site retention facilities and separations in CSO basins 3C and 25 as identified in the CSO reduction schedule

- Replace the remaining regulating structures and implement I/I reduction plans for the remaining CSO basins

- Construct pipe to connect the existing storm line above CSO regulator 20 to the existing storm outfall as described in Chapter 7

- Upgrade the interceptor system. These upgrades will include increasing pipe diameters to accommodate projected flows due to optimization, storage and future development within the City sewer service area. The projected upgrades are shown in Table 8-5.

- Increase the treatment plant capacity. The estimated costs associated with this upgrade reflect current regulatory requirements. These requirements may change, affecting the cost of modifications. Foreseeable treatment plant improvements include additional influent flow measurement, bar screens and grit chambers. Additional storage capacity would be needed. The feasibility of these upgrades for treatment plant operations will require further study.

- Optimization of existing interceptor capacity will include modification of six regulating weirs. These weirs are CSO regulators 2, 23, 7, 16B, and 10. Monitoring will continue at the regulator 23 site to assess the effectiveness of weir modification. These regulators were selected because the dynamic interceptor model indicates that one overflow per year is achievable at these sites through optimization alone, and there is baseline data from the November, 1991 monitoring effort. The increase in peak storm flow to the interceptors resulting from the optimization of these regulators is 5.2 mgd. Model runs show that the additional individual peak flows from these sources will be attenuated to an undetectable level at the time of peak flow to the treatment plant.

The estimated reduction in annual overflow volume by 2010, the completion of Phase 3, is 18 MG per year. The projected annual CSO volume in 2012 will therefore be under 60 MG per year, or 10.5 percent of the annual CSO discharge prior to 1983 (see Table 1-2). Of the 30 CSO regulators in 1992, 14 will overflow once per year or less by 2012. Of the 24 CSO outfalls in 1992, 11 will discharge once per year or less by 2012.

TABLE 8-5. INTERCEPTOR UPGRADES

Location	Manholes	Length (in feet)	Diameter (in inches)	Capital Cost ($1,000)
North River Interceptor	02030-Headworks	11,240	60	3,103
Surro to Greene on South Riverton	05087-05064	6,489	21	576
Hamilton Bridge to East Trent site	05015-05009	3,184	66	1,274
Ohio Avenue Interceptor	02046-02042	1,486	27	177
Summit & Sherwood to Nettleton & Bridge	37212-37201 37015-37010	819	21	252 82
Columbia Circle	24001-24000	114	15	10
Cedar & Ide	36001-36000	23	15	2
Total		23,355		5,476

8.3.4 Phase 4

The fourth and final phase of CSO reduction will occur after 2012. As with the third phase, projects and costs for the fourth phase are contingent upon the reduction achieved through the implementation of the prior phases. Those projects selected on a preliminary basis for the fourth phase include the following.

- In 2010 to 2012, the CSO Reduction Plan will be revised for a second time to reflect changes in the City and information collected during the first 20 years of CSO reduction effort. At the time of this revision, final planning will be done for Phase 4.

- Construct the storage facilities identified in the CSO reduction schedule, as modified following the second revision of this plan in 2012.

- Continue monitoring as necessary to assure that an average of one overflow event per year per outfall occurs over a 10 year period.

- If necessary, construct new primary clarifiers to handle increased loads following conversion of existing storm clarifiers to final clarifiers and a standby clarifier. Flow projections for 2010 and beyond indicate that conversion will be necessary to handle connections to existing development that has not been sewered, according to the Draft *Wastewater Facilities Planning Study* (Bovay, 1990).

The estimated reduction in annual overflow volume from all CSO reduction projects in Phases 1 through 4 is 70.2 MG per year. The resulting annual CSO volume will be 8.40 MG per year, and all CSO outfalls will have an average discharge frequency of one event per year or less by the completion of Phase 4.

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